



US009180476B2

(12) **United States Patent**
Werner et al.

(10) **Patent No.:** **US 9,180,476 B2**
(45) **Date of Patent:** ***Nov. 10, 2015**

(54) **MIXING AND DISPENSING DEVICE**

USPC 239/303–305, 407, 413, 416.1;
137/896–898, 605; 222/129–133,
222/135–137, 144.5, 145.1, 145.5–145.7,
222/159, 183, 321.7, 325, 402.23, 80–91,
222/464.1–464.7

(71) Applicant: **Mouse Trap Design, LLC**, Pittsburgh,
PA (US)

(72) Inventors: **Melanie R. Werner**, Pittsburgh, PA
(US); **Paul J. Mulhauser**, New York,
NY (US); **Karl D. Kirk, III**, Great
Barrington, MA (US)

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

704,105 A * 7/1902 Reed 222/144.5
2,118,704 A * 5/1938 Grontkowski 222/61

(Continued)

(73) Assignee: **Mouse Trap Design, LLC**, Sewickley,
PA (US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

This patent is subject to a terminal dis-
claimer.

FOREIGN PATENT DOCUMENTS

DE 295119321 11/1996
DE 102006027778 A1 5/2008

(Continued)

OTHER PUBLICATIONS

Title: MIKS Trail Dispenser URL: <http://www.interzinc.com/zinc-challenge/results.html> Accessed: Dec. 19, 2012.

(Continued)

(21) Appl. No.: **13/998,553**

(22) Filed: **Nov. 7, 2013**

(65) **Prior Publication Data**

US 2014/0076930 A1 Mar. 20, 2014

Primary Examiner — Paul R Durand

Assistant Examiner — Randall Gruby

(74) *Attorney, Agent, or Firm* — Alicia M. Passerin, Esq.;
Pietragallo Gordon Alfano Bosick & Raspanti, LLP

(57)

ABSTRACT

A device for dispensing a mixture of at least two fluids is disclosed. The device has a plurality of cartridges that each contain a fluid. A flow channel communicates with each cartridge. A valve adjusts a mass flow rate of the fluid drawn from the corresponding cartridge. A manifold has a mixing chamber and a plurality of inlets that each communicate with one of the flow channels. The manifold has a spring and a seal that covers the inlets. A piston is between the seal and the spring. The spring is moveable between an extended position that positions the seal to substantially and simultaneously close the inlets from the flow channels and a compressed position that positions the seal to substantially and simultaneously open the inlets to the flow channels. A dispensing pump communicates with the manifold and draws fluid from each of the cartridges. A nozzle dispenses the mixture.

18 Claims, 38 Drawing Sheets

Related U.S. Application Data

(63) Continuation of application No. 13/462,461, filed on
May 2, 2012, now Pat. No. 8,596,498.

(60) Provisional application No. 61/481,553, filed on May
2, 2011, provisional application No. 61/560,560, filed
on Nov. 16, 2011.

(51) **Int. Cl.**

B67D 7/78 (2010.01)

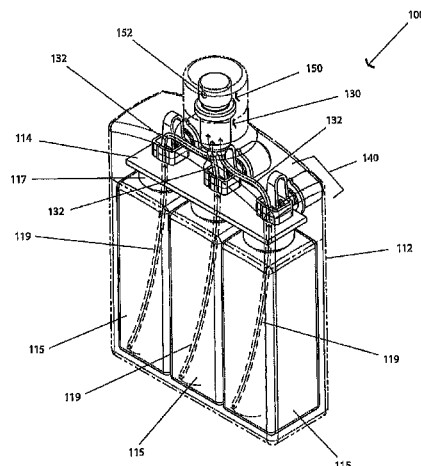
B05B 11/00 (2006.01)

(52) **U.S. Cl.**

CPC **B05B 11/3083** (2013.01)

(58) **Field of Classification Search**

CPC B05B 11/3081; B05B 11/3083; B05B
11/00443; B05B 11/0054; B05B 11/0064



(56)

References Cited

U.S. PATENT DOCUMENTS

- 2,400,955 A * 5/1946 Samel 141/302
 2,608,320 A * 8/1952 Harrison, Jr. 222/95
 2,941,696 A * 6/1960 Homm 222/136
 3,208,639 A * 9/1965 Marwell et al. 222/82
 3,236,418 A * 2/1966 Dalle et al. 222/135
 3,384,119 A * 5/1968 Manoogian 137/625.17
 3,392,859 A * 7/1968 Fischer 215/247
 3,521,792 A * 7/1970 Davidson 222/136
 3,608,782 A * 9/1971 Sathicq 222/94
 3,610,472 A * 10/1971 Bruno 222/145.5
 3,685,694 A * 8/1972 Ianelli 222/82
 3,709,437 A * 1/1973 Wright 239/343
 3,760,986 A * 9/1973 Castner et al. 222/137
 3,786,963 A * 1/1974 Metzler, III 222/136
 3,813,011 A * 5/1974 Harrison et al.
 3,865,134 A * 2/1975 Holcomb 137/594
 4,006,841 A * 2/1977 Alticosalian
 4,011,288 A * 3/1977 Assenheimer et al. 261/121.1
 4,129,231 A * 12/1978 Larson 222/145.5
 4,285,445 A * 8/1981 Vander Molen et al. 222/49
 4,372,100 A * 2/1983 Miller et al. 53/428
 4,469,250 A * 9/1984 Evezich 222/83.5
 4,484,597 A * 11/1984 Bravo 137/512.1
 4,496,081 A * 1/1985 Farrey 222/135
 4,549,674 A * 10/1985 Alticosalian
 4,770,323 A * 9/1988 Debard 222/82
 4,826,048 A * 5/1989 Skorka et al. 222/137
 4,881,575 A * 11/1989 Smith 137/889
 4,993,594 A * 2/1991 Becker et al. 222/48
 5,009,342 A * 4/1991 Lawrence et al. 222/136
 5,152,461 A * 10/1992 Proctor 239/304
 5,169,029 A * 12/1992 Behar et al.
 5,188,455 A * 2/1993 Hammerstedt 366/177.1
 5,197,638 A * 3/1993 Wood 222/212
 5,332,157 A * 7/1994 Proctor
 5,385,270 A * 1/1995 Cataneo et al. 222/134
 5,398,846 A * 3/1995 Corba et al.
 5,402,916 A * 4/1995 Nottingham et al. 222/134
 5,431,185 A * 7/1995 Shannon et al. 137/512.4
 5,433,350 A * 7/1995 Graubart 222/136
 5,562,250 A * 10/1996 O'Neill 239/304
 5,617,976 A * 4/1997 Gueret 222/380
 5,634,571 A * 6/1997 Cataneo et al.
 5,720,315 A * 2/1998 Palmer 137/240
 5,769,275 A * 6/1998 Boehmer et al. 222/136
 5,848,730 A * 12/1998 Kawase et al. 222/94
 5,848,732 A * 12/1998 Brugger
 5,865,797 A * 2/1999 Zeeman 604/80
 5,897,539 A * 4/1999 Elliesen et al.
 5,967,373 A * 10/1999 Seager et al.
 RE36,410 E * 11/1999 Meshberg 141/2
 6,082,593 A * 7/2000 Borchers 222/181.3
 6,223,788 B1 * 5/2001 Taylor
 6,328,543 B1 * 12/2001 Benecke 417/411
 6,543,490 B1 * 4/2003 Owens
 6,557,732 B2 * 5/2003 Van Rompuy et al.
 6,634,524 B1 * 10/2003 Helmenstein 222/94
 6,719,729 B2 * 4/2004 Sogaro
 6,736,288 B1 * 5/2004 Green 222/94
 6,793,098 B2 * 9/2004 Huber et al.
 6,863,660 B2 * 3/2005 Marx 604/147
 6,877,638 B2 * 4/2005 Chan et al.
 6,971,549 B2 * 12/2005 Leifheit et al. 222/83
 7,021,499 B2 * 4/2006 Hansen et al. 222/145.5
 7,036,685 B1 * 5/2006 Green 222/94
 7,044,402 B2 * 5/2006 Finn
 7,152,758 B2 * 12/2006 Fazzio et al.
 7,222,802 B2 * 5/2007 Sweeton
 7,267,248 B2 * 9/2007 Yerby et al.
 7,377,404 B2 * 5/2008 Cherfane
 7,481,334 B2 * 1/2009 Arghyris et al. 222/137
 7,481,335 B2 * 1/2009 Owens
 7,487,888 B1 * 2/2009 Pierre, Jr.
 7,487,889 B2 * 2/2009 Owens
 7,506,754 B2 * 3/2009 Segovia et al. 206/219
 7,537,139 B2 * 5/2009 Jackson et al.
 7,559,440 B2 * 7/2009 Rueschhoff et al.
 7,594,594 B2 * 9/2009 Troost et al.
 7,641,075 B2 * 1/2010 Crews
 7,717,297 B2 * 5/2010 Kadyk et al.
 7,775,401 B2 * 8/2010 Banco et al.
 7,789,273 B2 * 9/2010 Kadyk et al.
 7,789,278 B2 * 9/2010 Ruiz de Gopegui et al.
 7,819,342 B2 * 10/2010 Spallek et al. 239/424.5
 7,861,893 B2 * 1/2011 Voegele et al.
 7,875,001 B2 * 1/2011 Minotti
 7,967,220 B2 * 6/2011 Hansen et al.
 8,523,017 B2 * 9/2013 Vellutato et al. 222/145.5
 8,684,233 B2 * 4/2014 Nishio et al. 222/145.1
 2001/0025859 A1 * 10/2001 Dumont
 2003/0075573 A1 * 4/2003 Bailey 224/148.2
 2004/0159677 A1 * 8/2004 Hwang 222/145.5
 2007/0012725 A1 * 1/2007 Jajeh
 2007/0069046 A1 * 3/2007 Eini et al. 239/418
 2008/0110930 A1 * 5/2008 Wittkamp et al.
 2008/0203110 A1 * 8/2008 LaFlamme et al.
 2009/0005903 A1 * 1/2009 Winsness
 2009/0152298 A1 * 6/2009 Woolfson et al. 222/144.5
 2009/0194561 A1 * 8/2009 Quasters 222/1
 2009/0216183 A1 * 8/2009 Minotti 604/82
 2010/0065130 A1 * 3/2010 Swab et al. 137/170.1
 2010/0108779 A1 * 5/2010 Filsouf 239/61
 2010/0133293 A1 * 6/2010 Ziesel
 2010/0185322 A1 * 7/2010 Bylsma et al.
 2010/0252574 A1 * 10/2010 Busin
 2010/0264162 A1 * 10/2010 Cratensburg et al.
 2011/0011888 A2 * 1/2011 Bevis et al.
 2011/0079610 A1 * 4/2011 Kadyk et al.
 2011/0121034 A1 * 5/2011 Swab et al.
 2011/0139180 A1 * 6/2011 Williams et al.
 2011/0174837 A1 * 7/2011 Nelson et al. 222/129
 2011/0204090 A1 * 8/2011 Worthington et al.
 2011/0215113 A1 * 9/2011 Hansen et al.
 2011/0259919 A1 * 10/2011 Choiniere et al.
 2011/0303694 A1 * 12/2011 Pié

FOREIGN PATENT DOCUMENTS

EP 0676339 A2 10/1995
 FR 1408299 A 8/1965
 WO 2008/053311 A2 5/2008

OTHER PUBLICATIONS

Title: Dual-chambered dispenser URL: <http://www.packworld.com/applications/personal-care/dual-chambered-dispenser> Accessed: Jun. 28, 2012.

Title: Variblend URL: <http://www.variblend.com> Accessed: Dec. 19, 2012.

Title: Dual-chamber Yonwoo dispenser for Biotherm Age Fitness Elastic URL: <http://www.quadpack.net/uk/our-products/latest-launches/dual-chamber-yonwoo-dispenser-for-biotherm-age-fitness-elastic/> Accessed: Jun. 28, 2012.

Title: Two-in-One bottle for olive oil and vinegar URL: <http://bestinpackaging.com/2011/05/05/dual-chamber-bottles/> Accessed: Dec. 19, 2012.

* cited by examiner

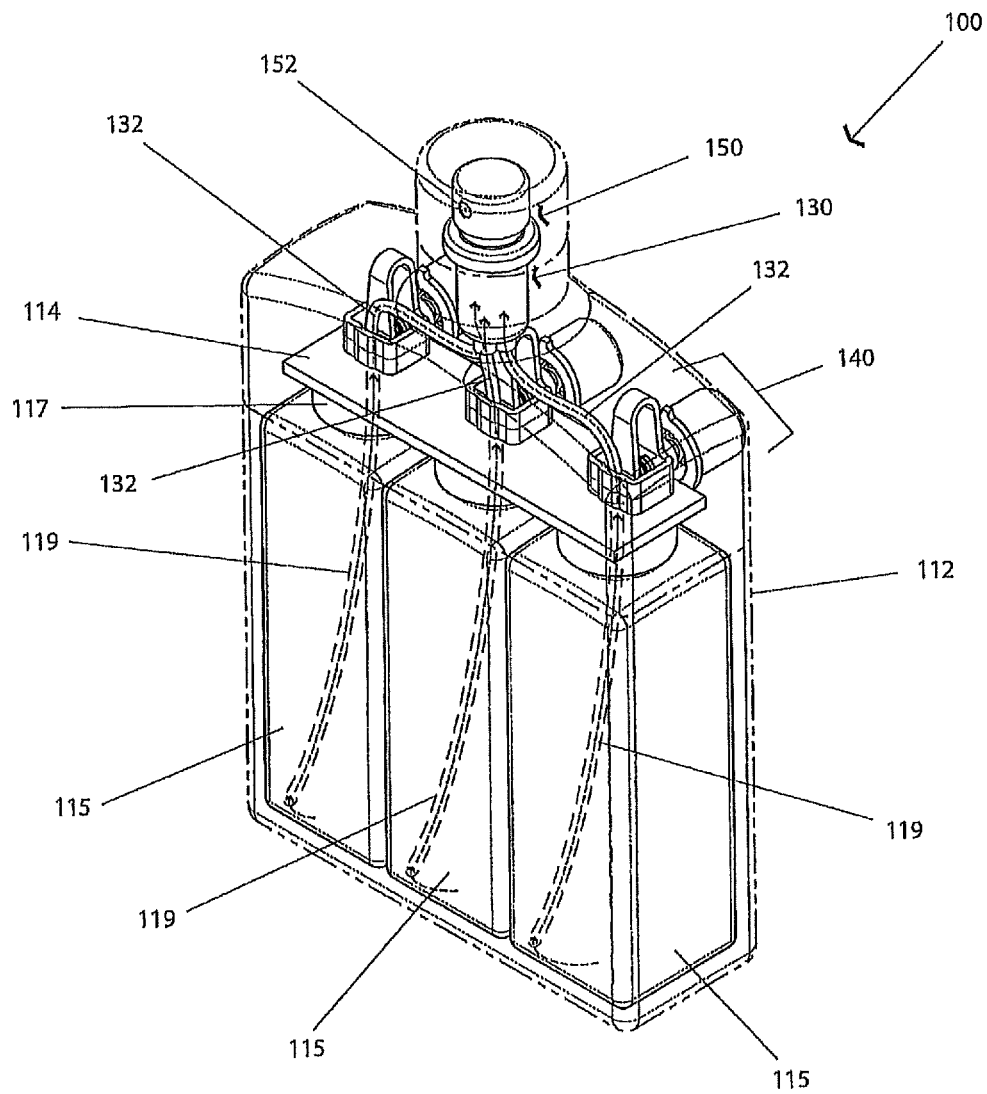


Fig. 1A

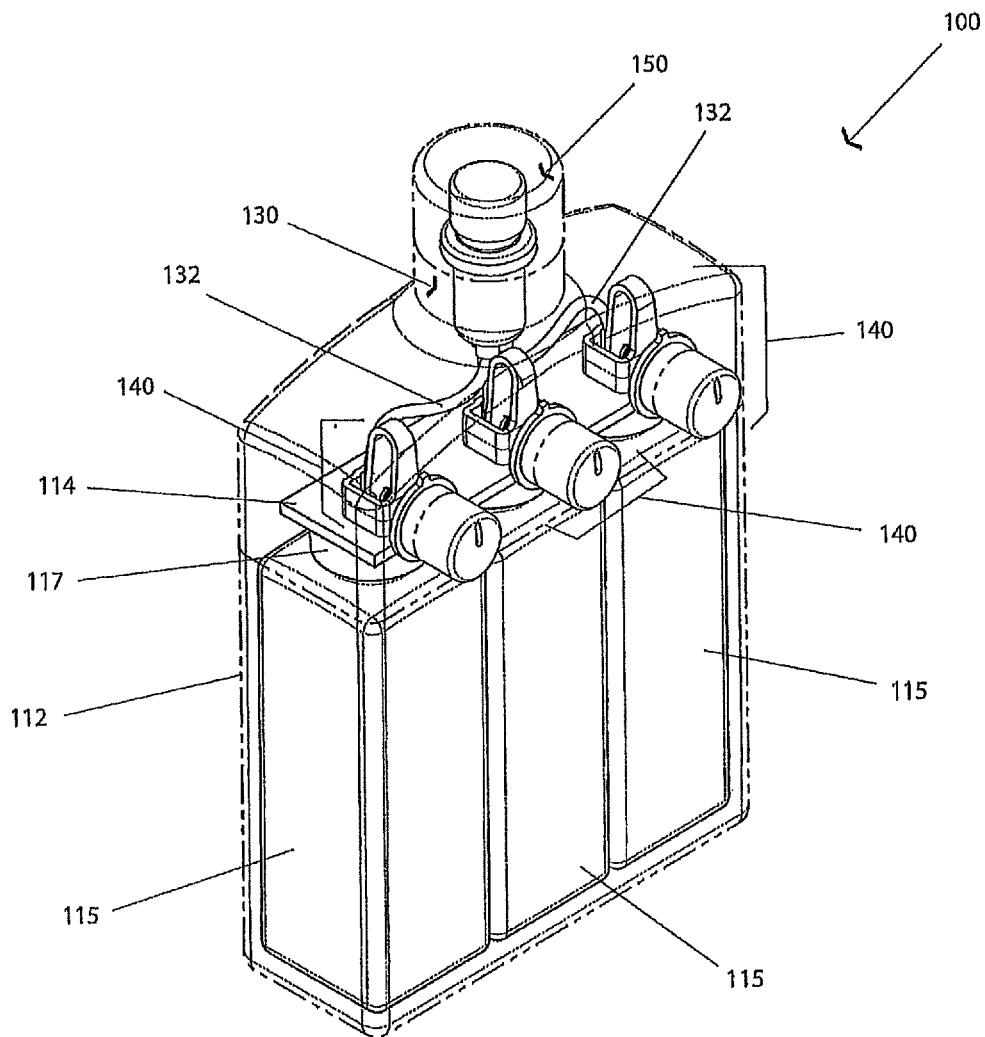


Fig. 1B

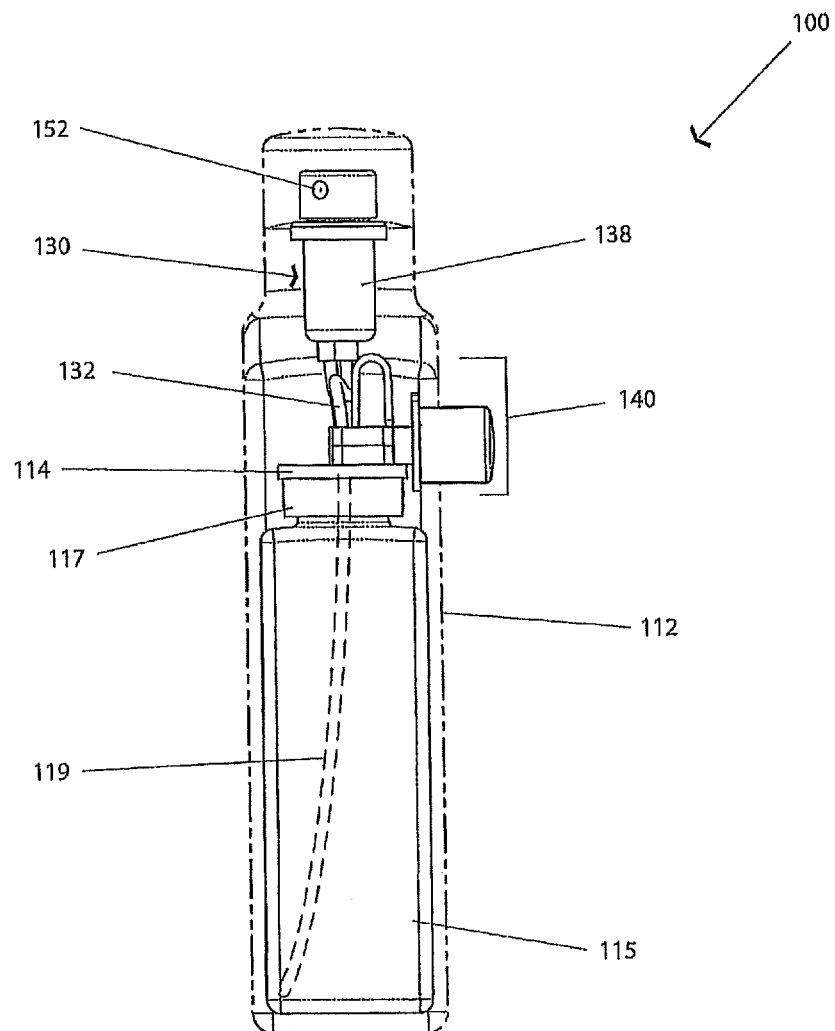
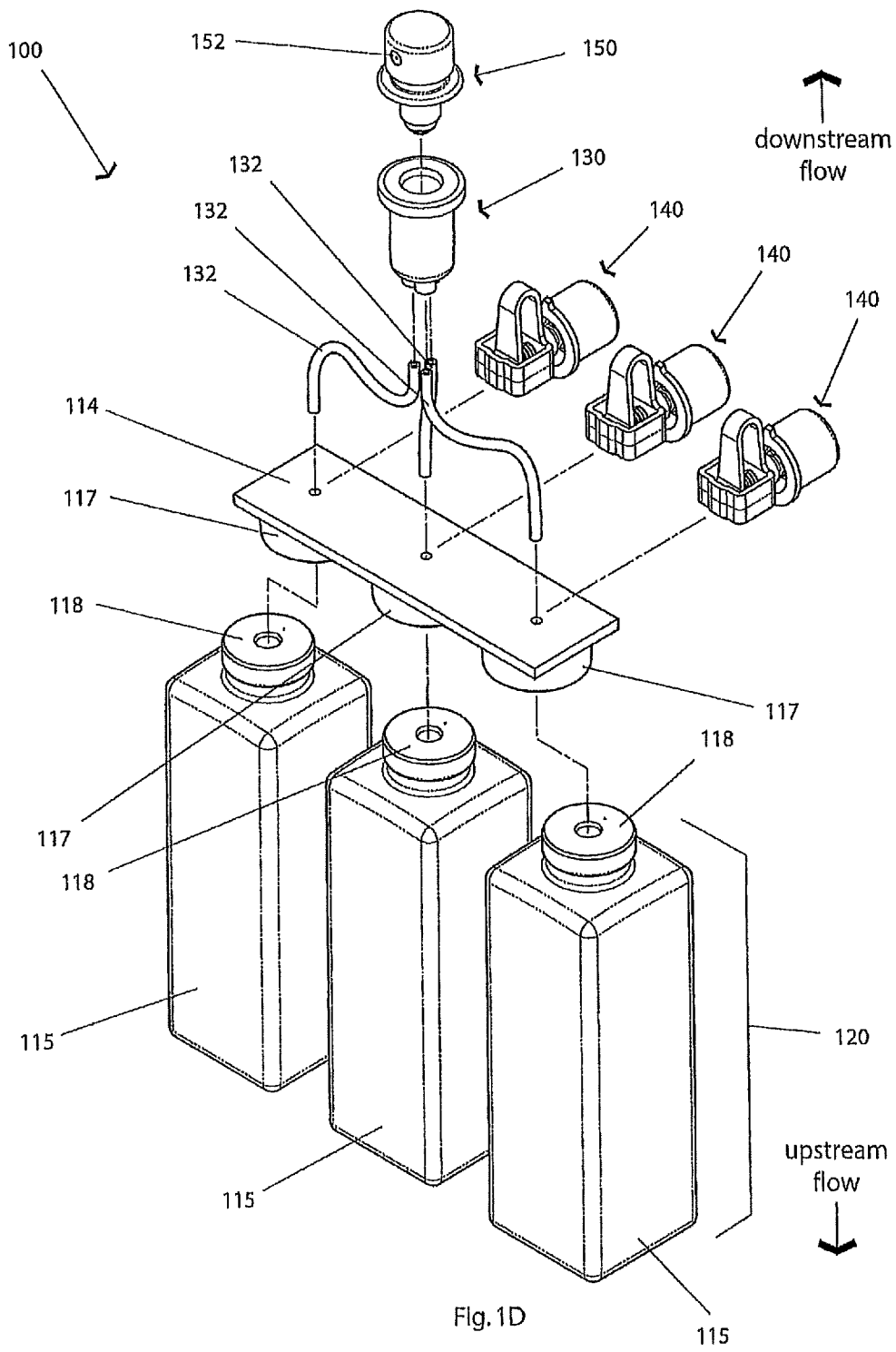


Fig. 1C



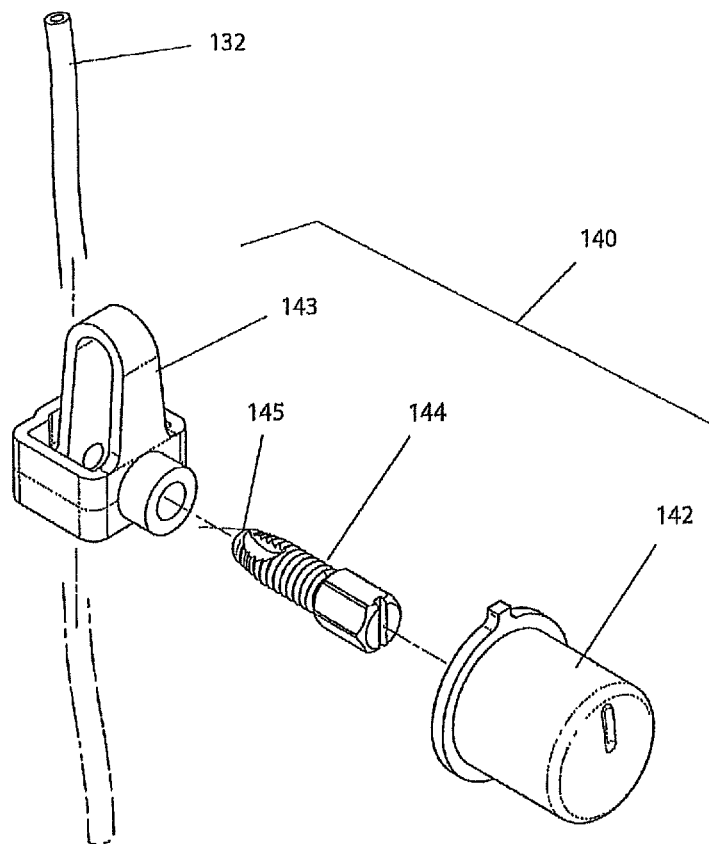


Fig. 1E

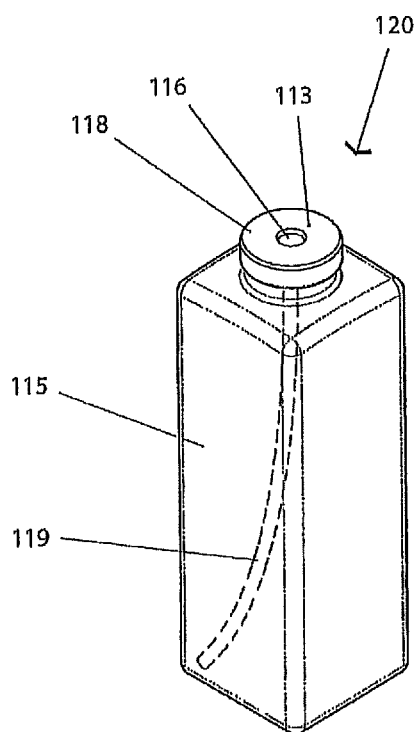


Fig. 1F

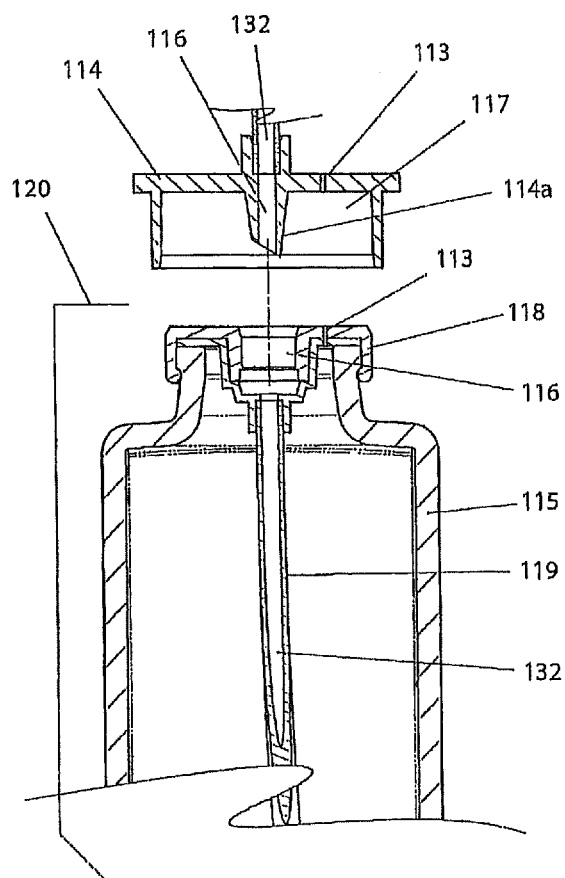


Fig. 1G

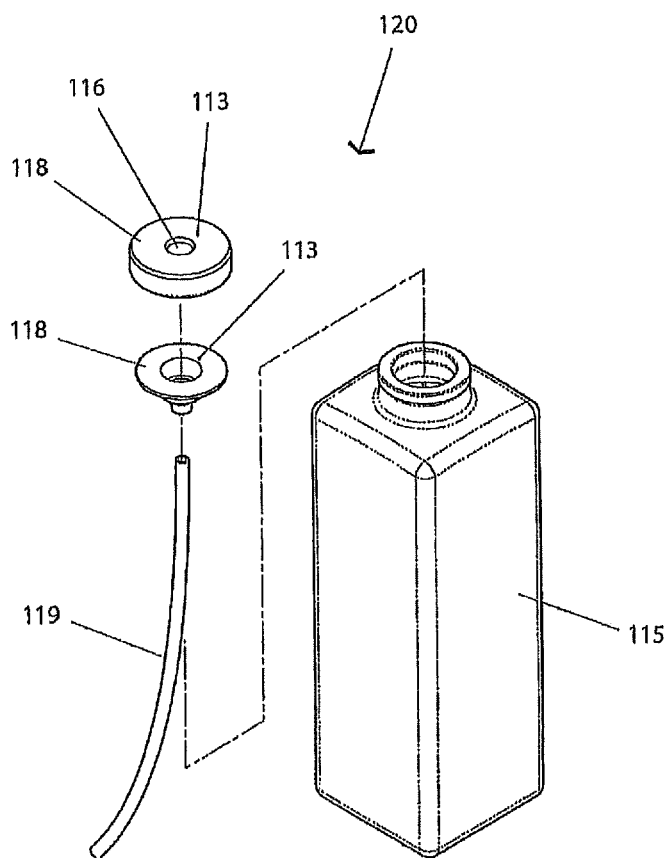


Fig. 1H

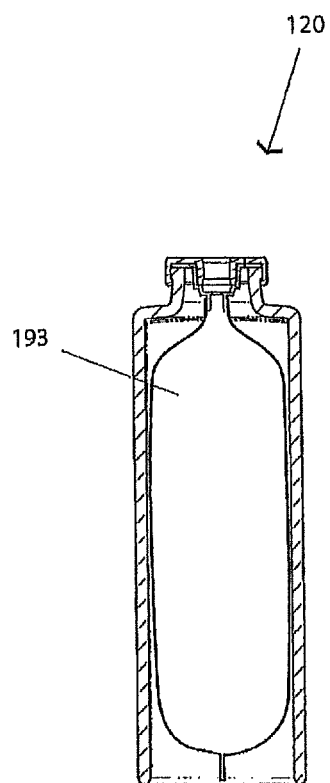


Fig. 1I

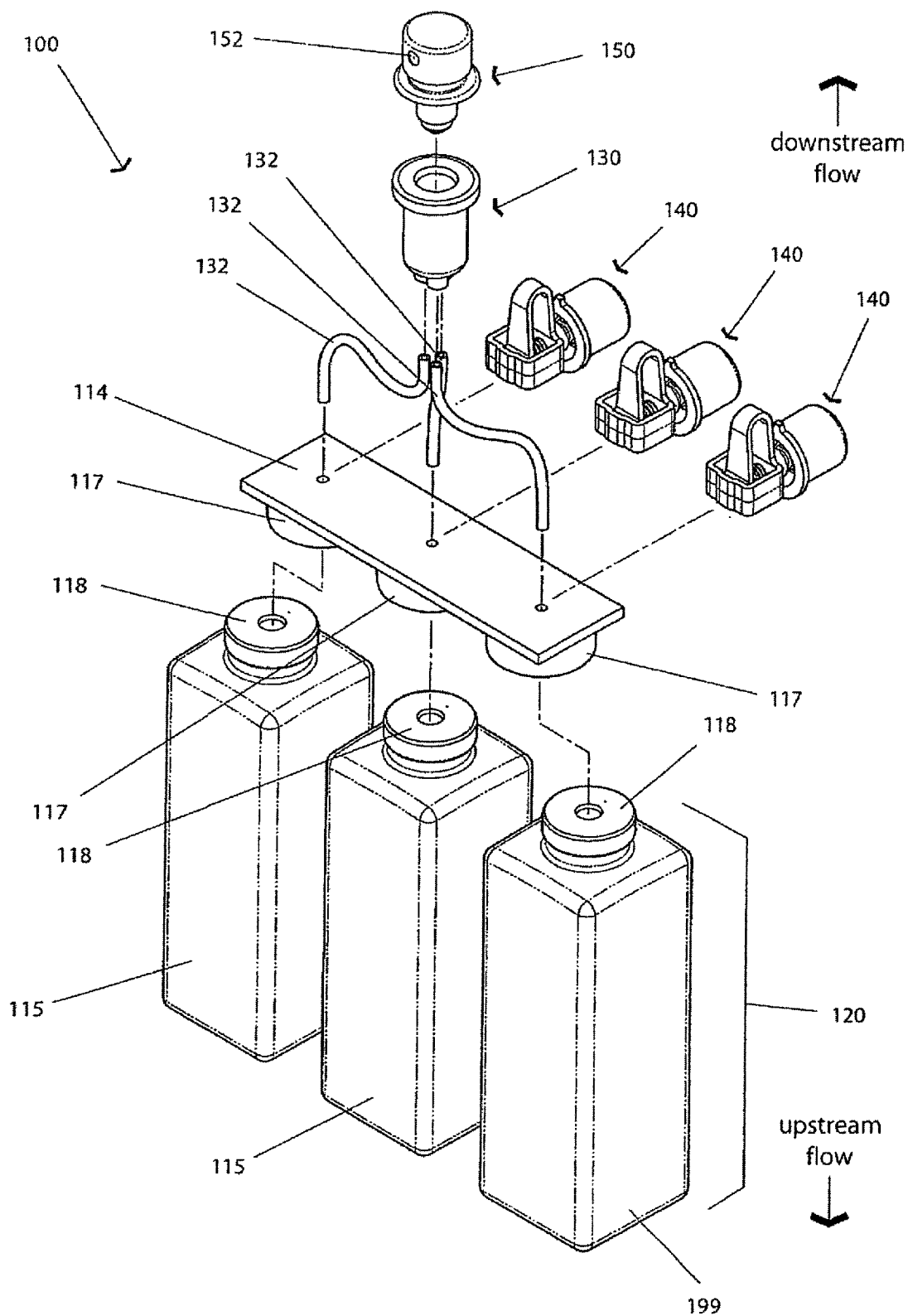


Fig. 1J

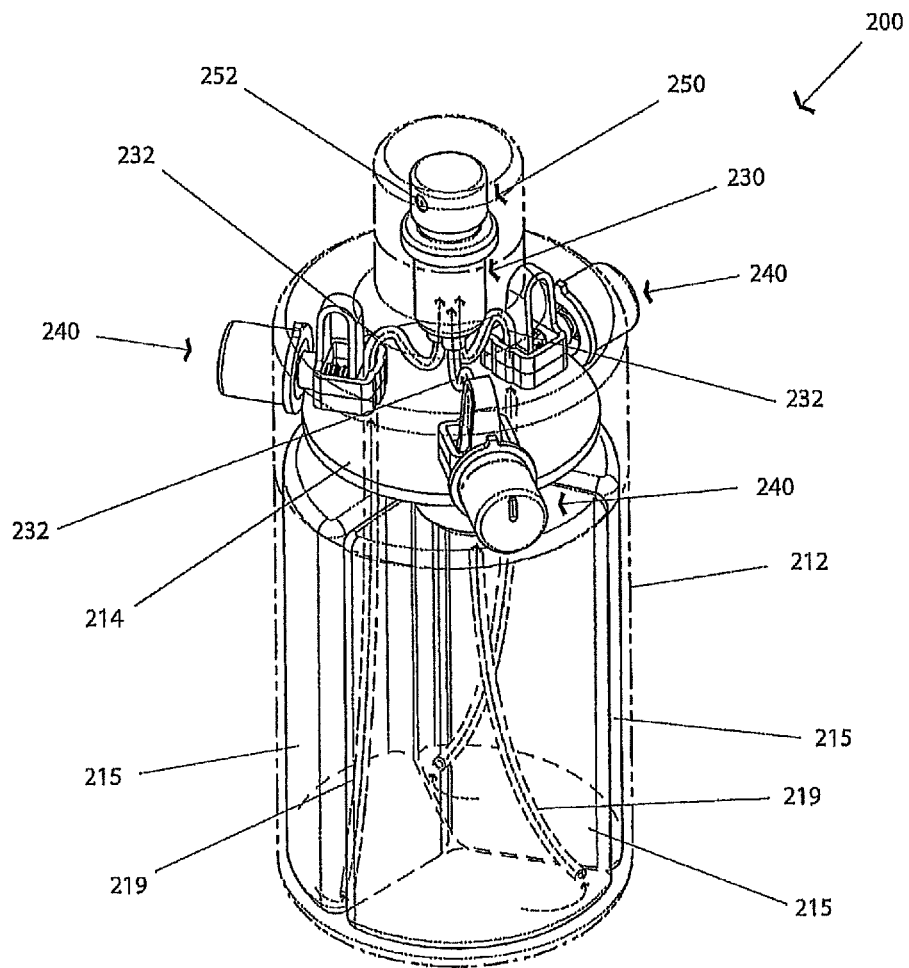


Fig. 2A

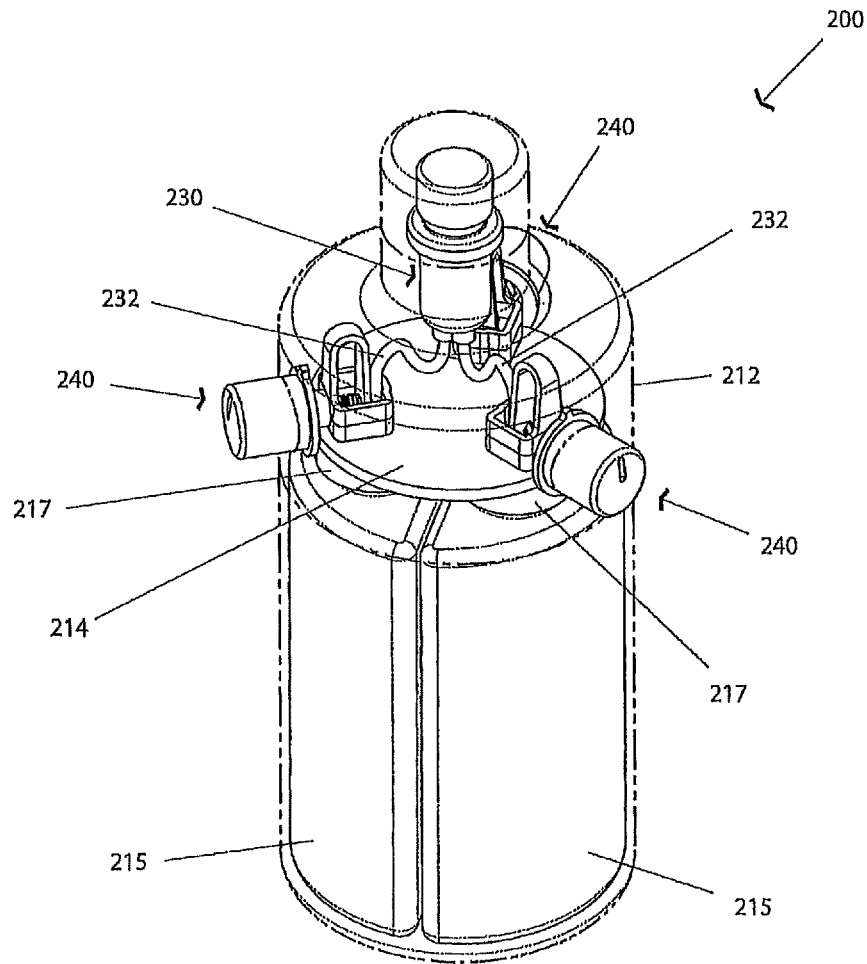


Fig. 2B

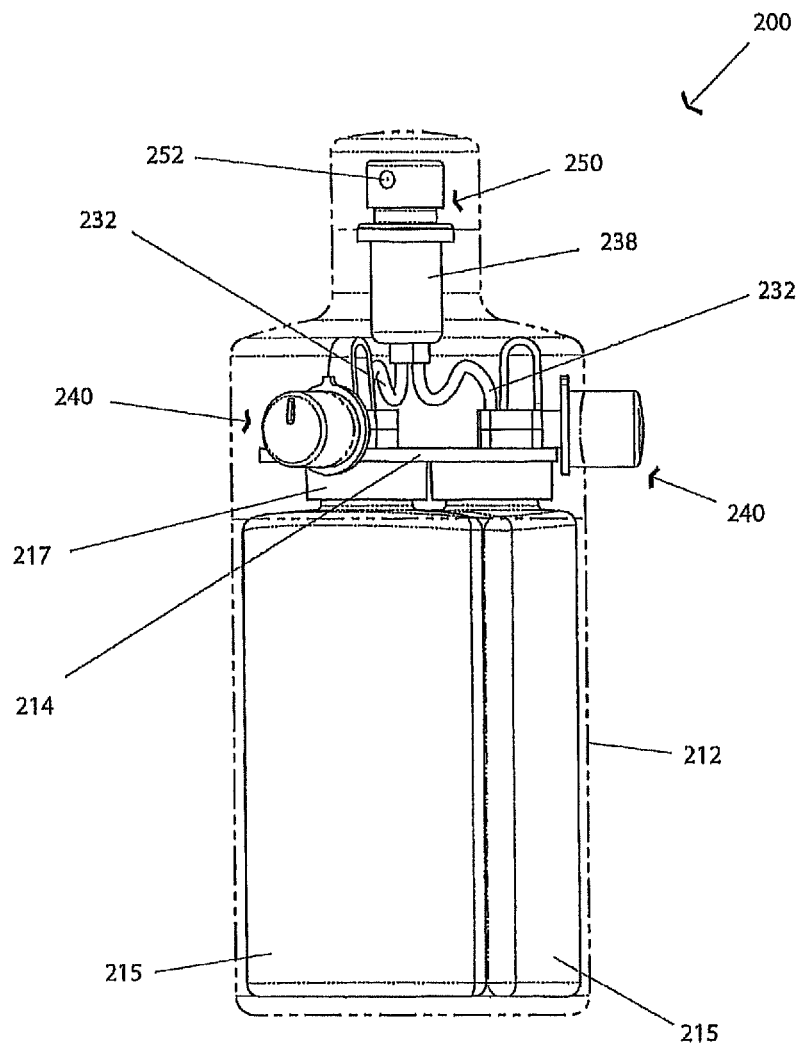


Fig. 2C

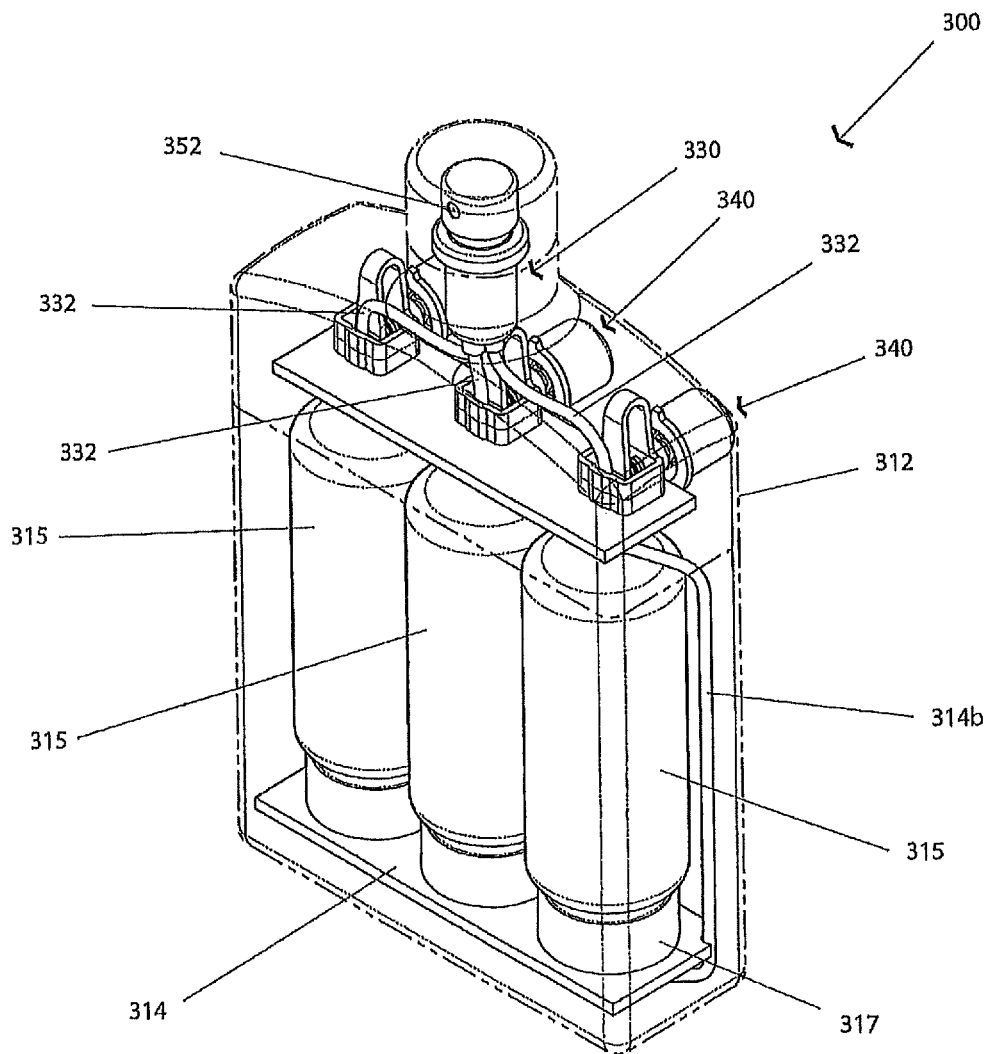
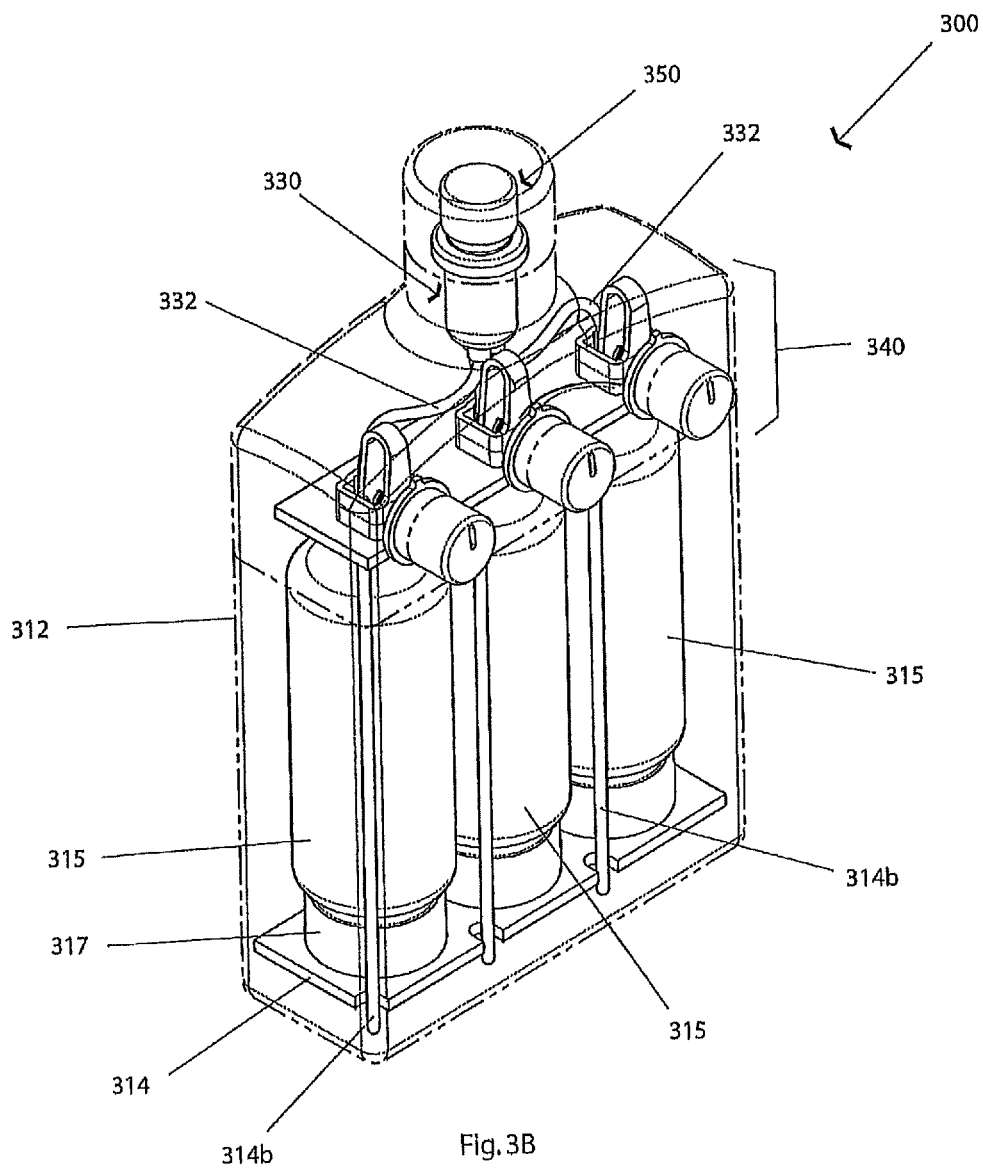


Fig. 3A



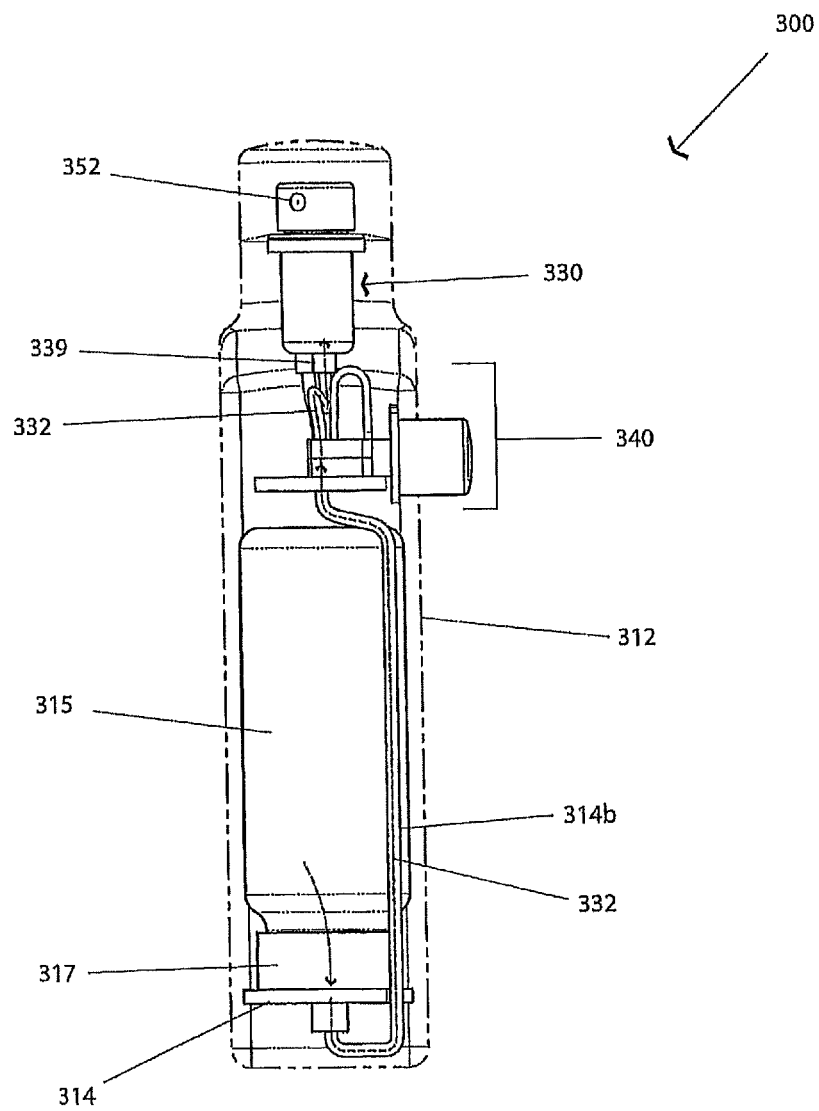


Fig. 3C

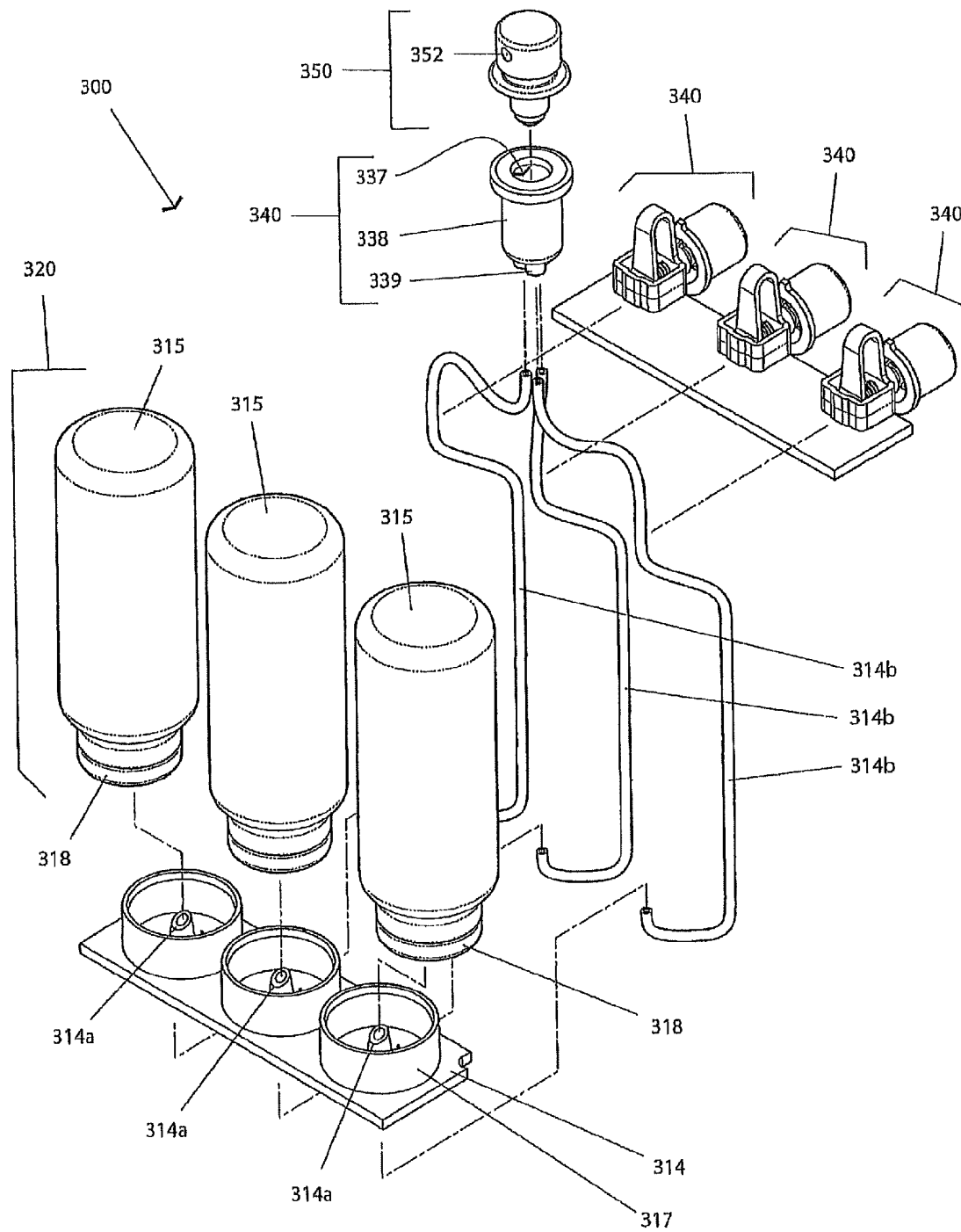
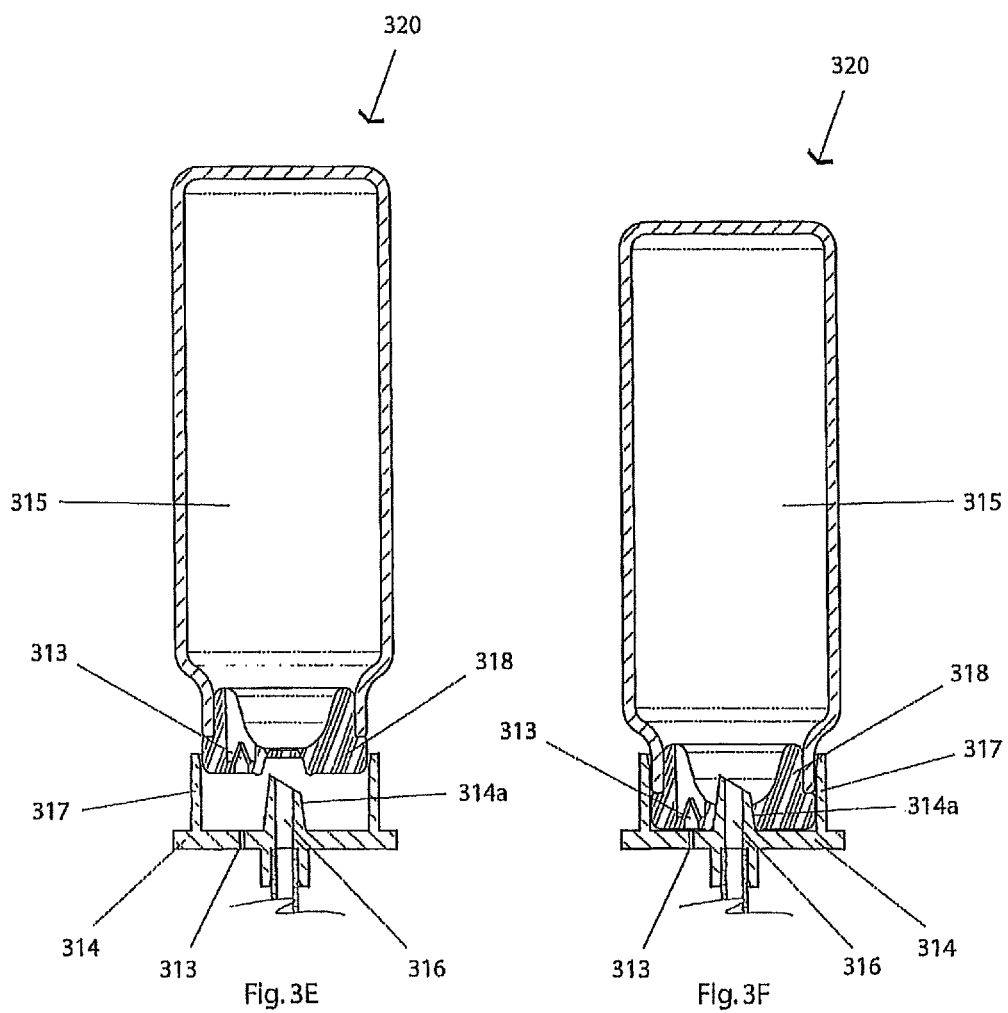


Fig.3D



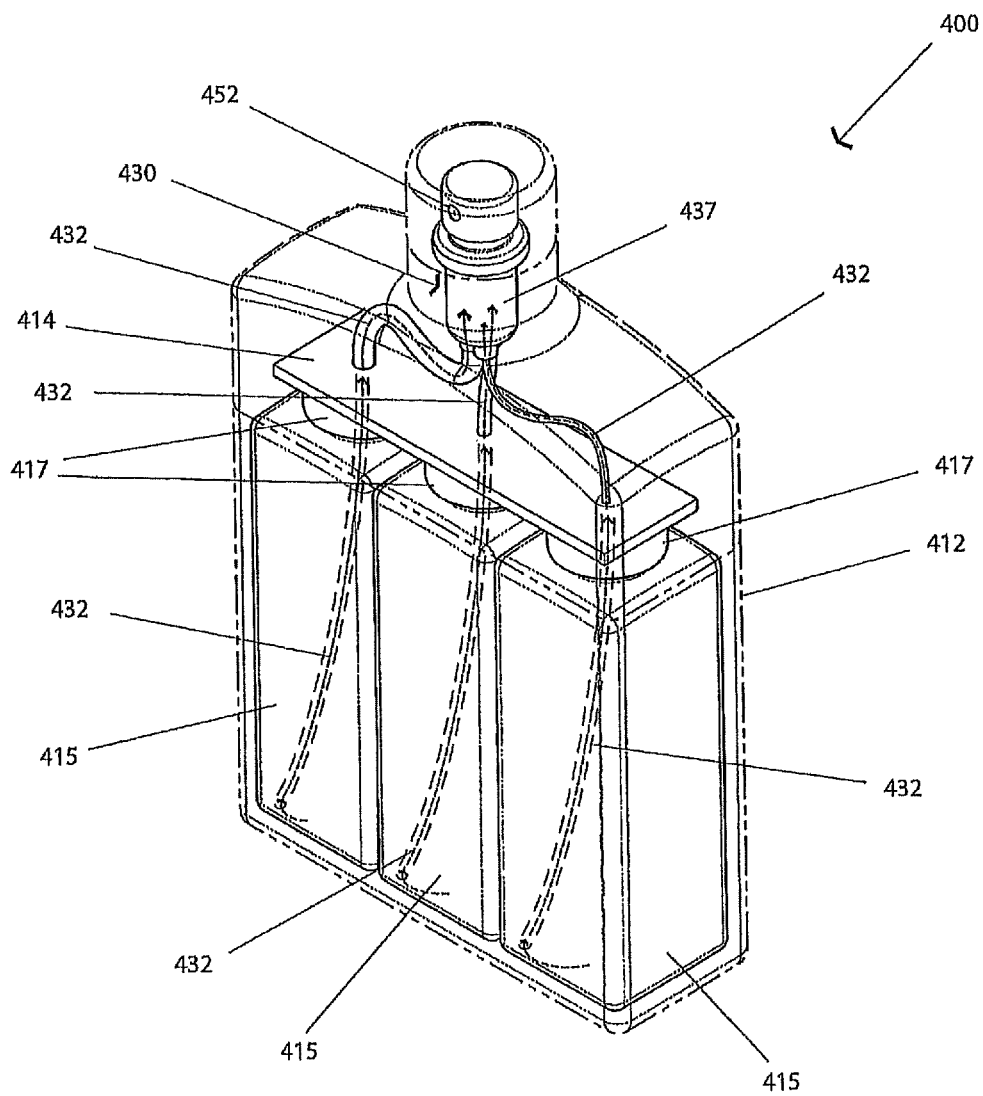


Fig. 4A

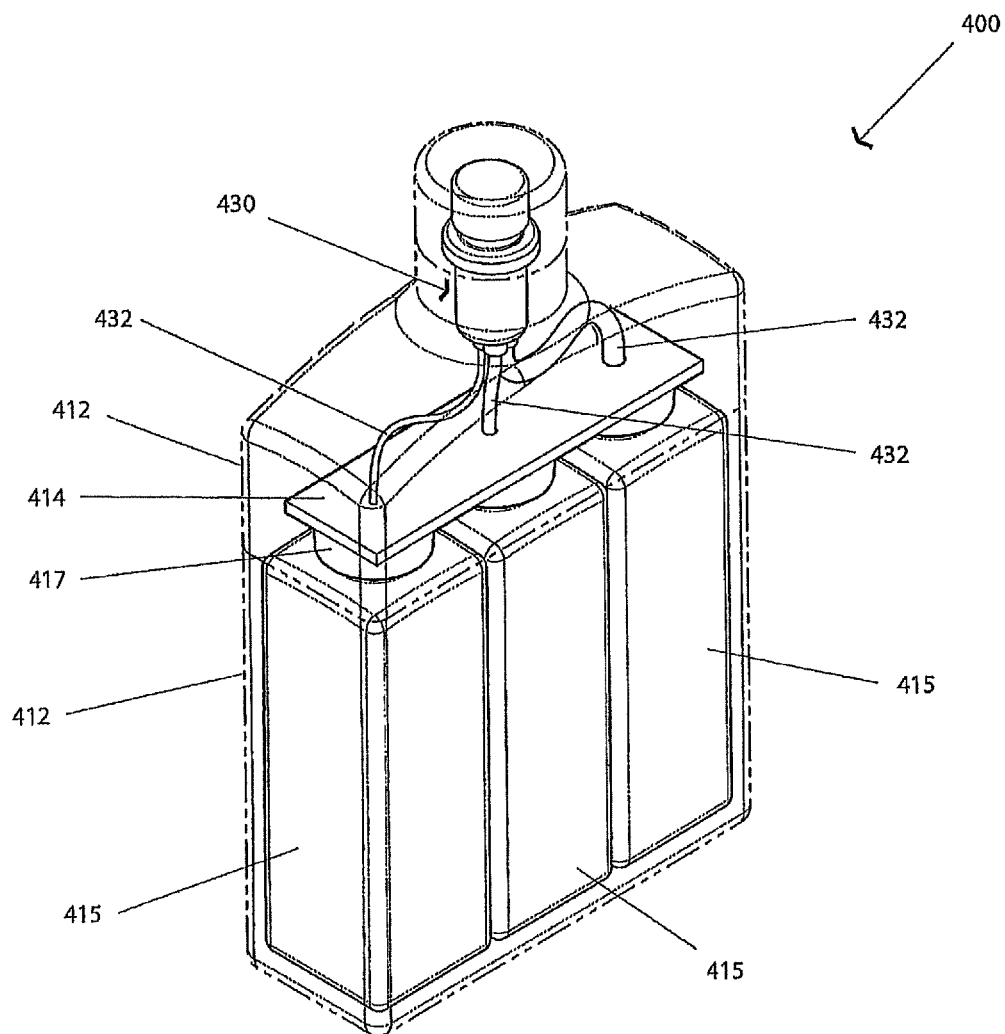


Fig. 4B

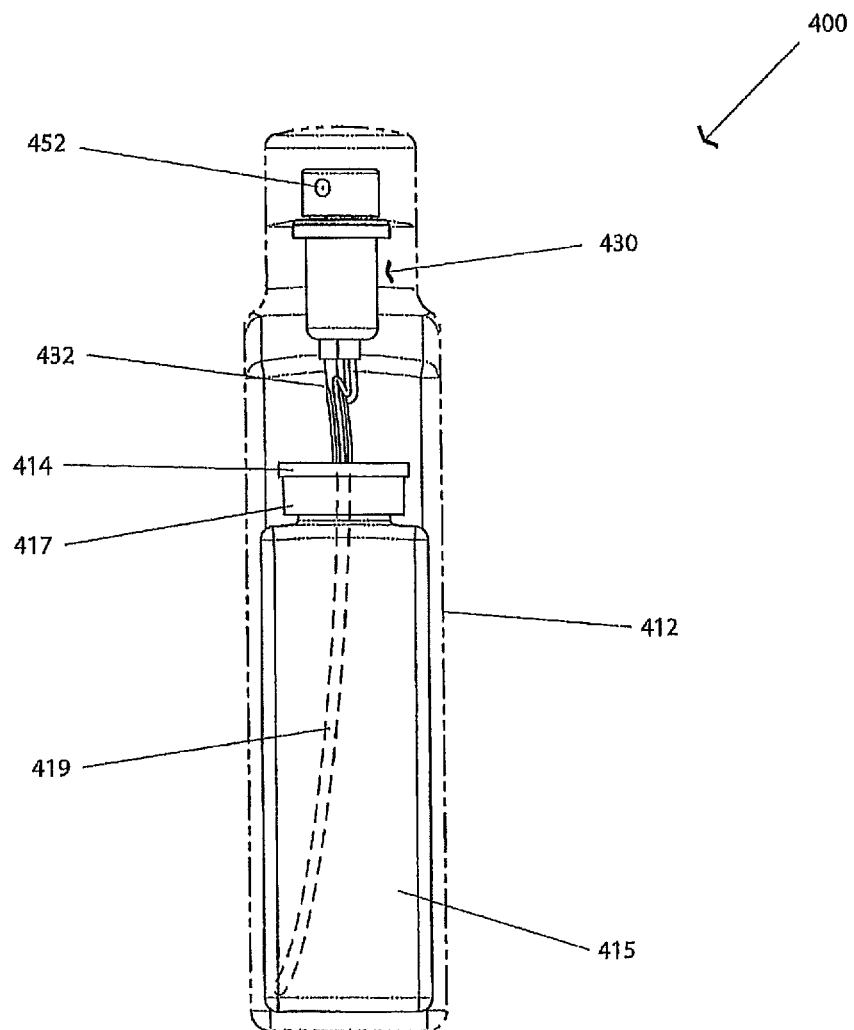


Fig. 4C

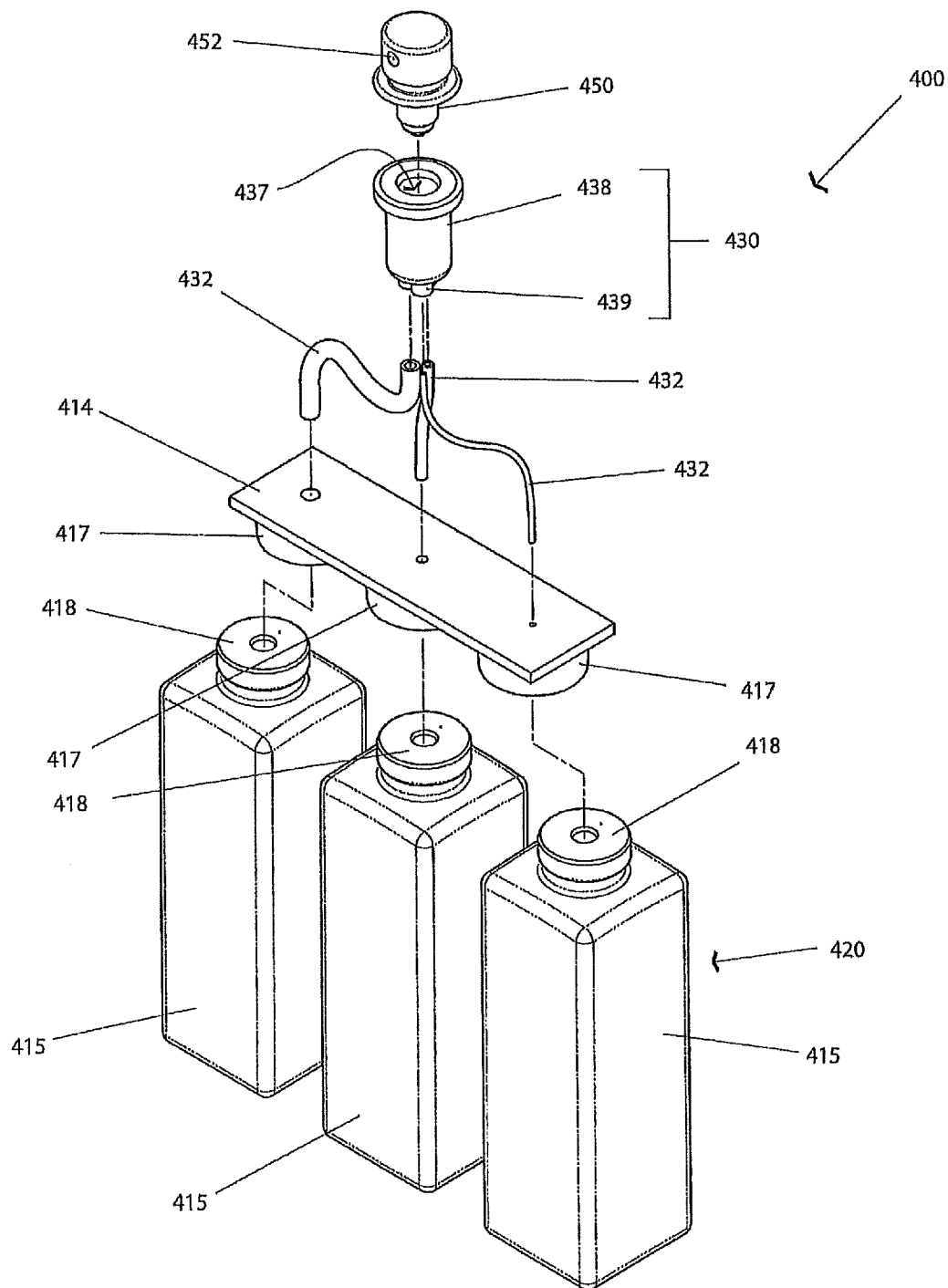
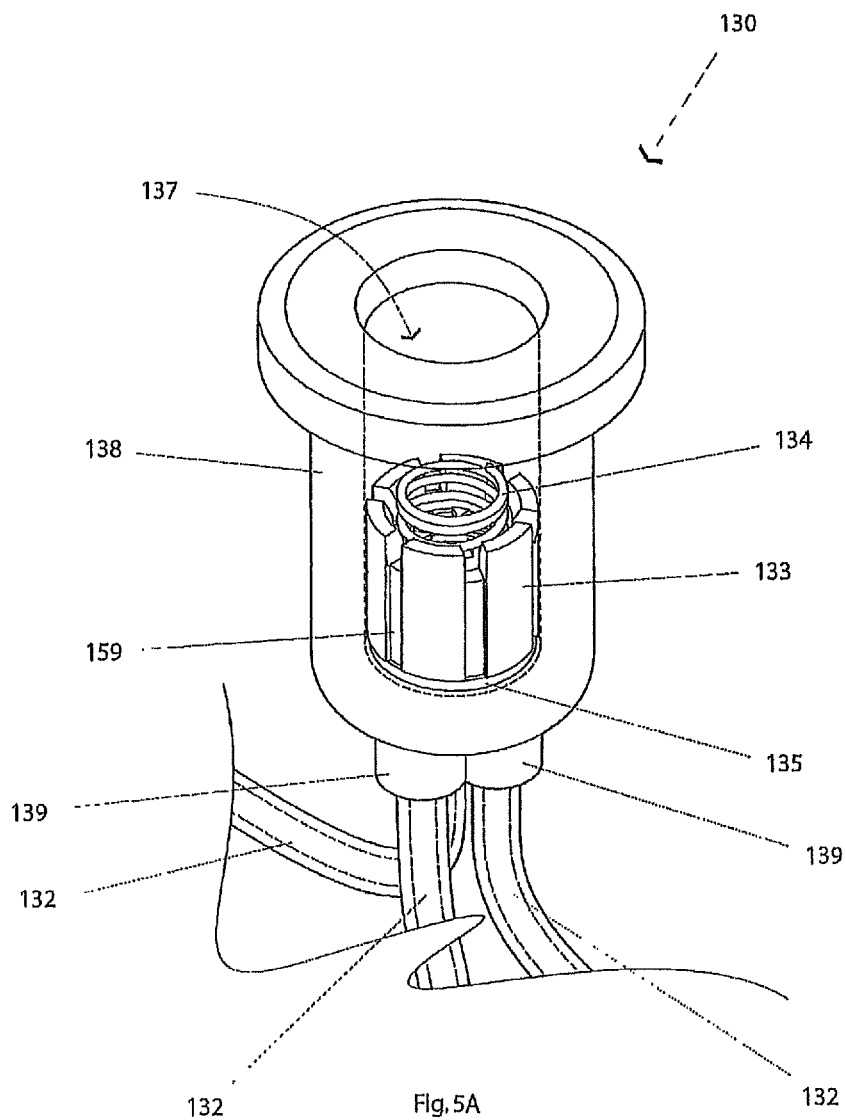


Fig. 4D



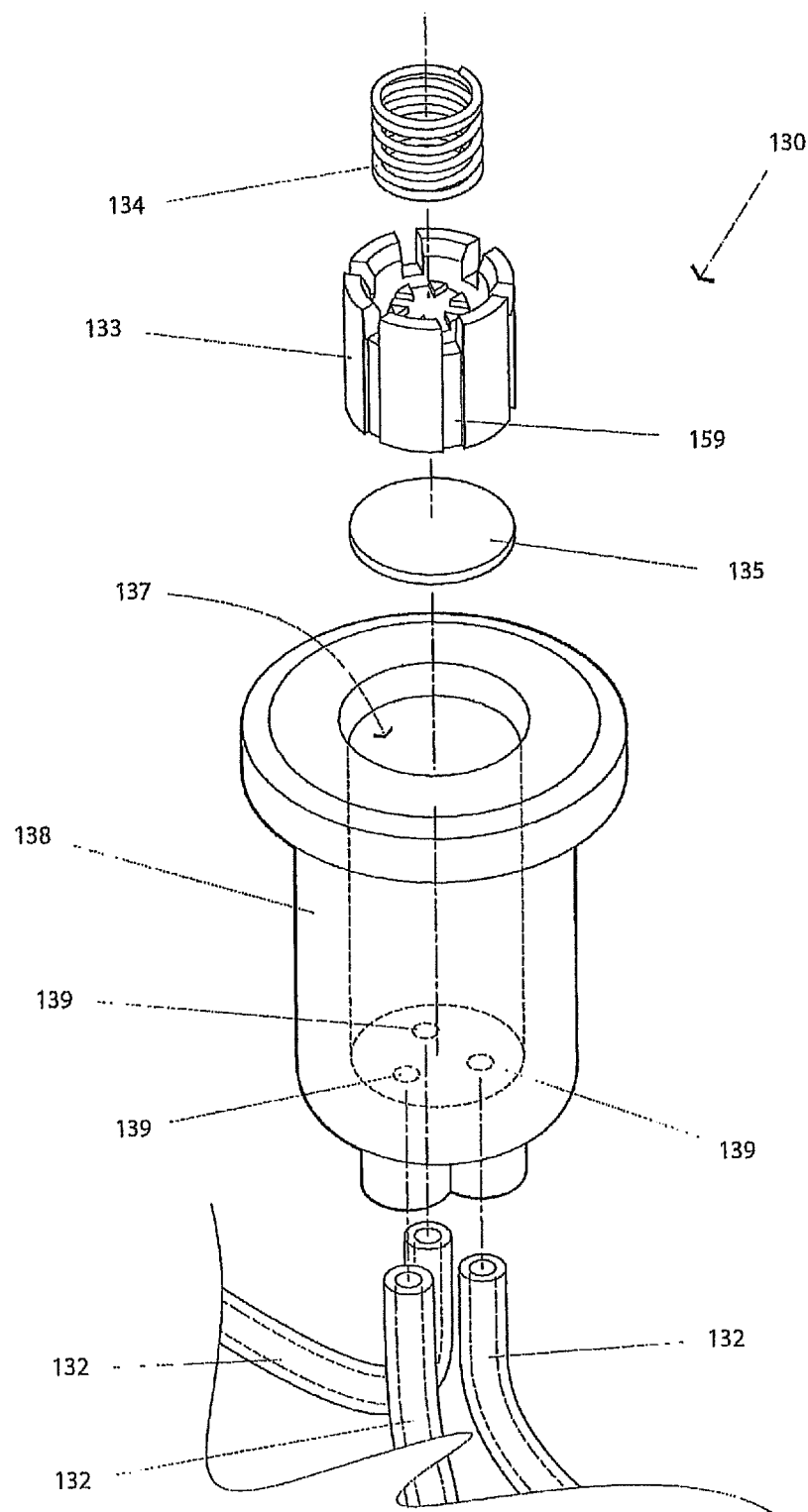


Fig. 5B

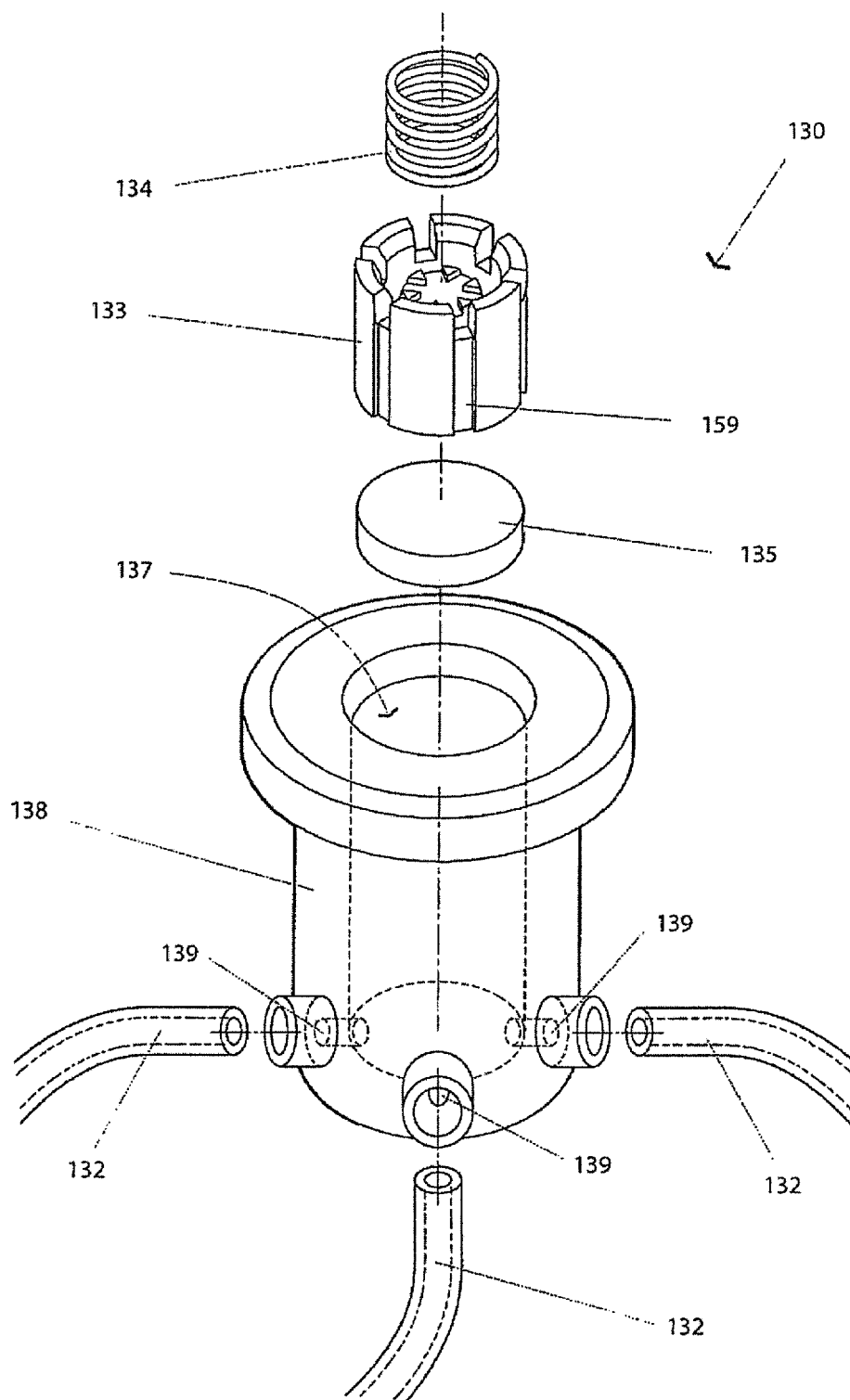
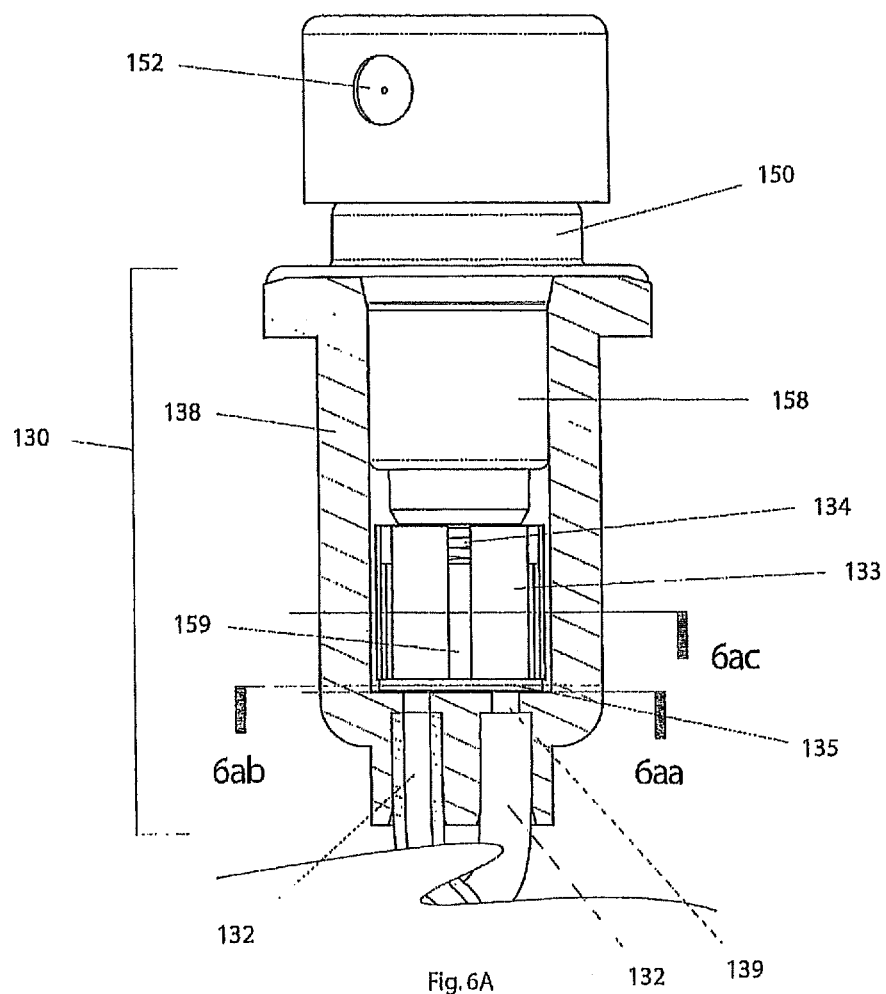


Fig. 5C



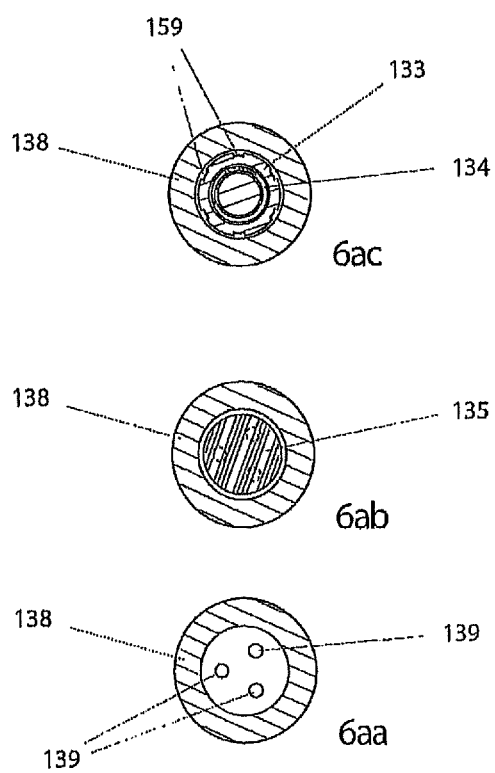
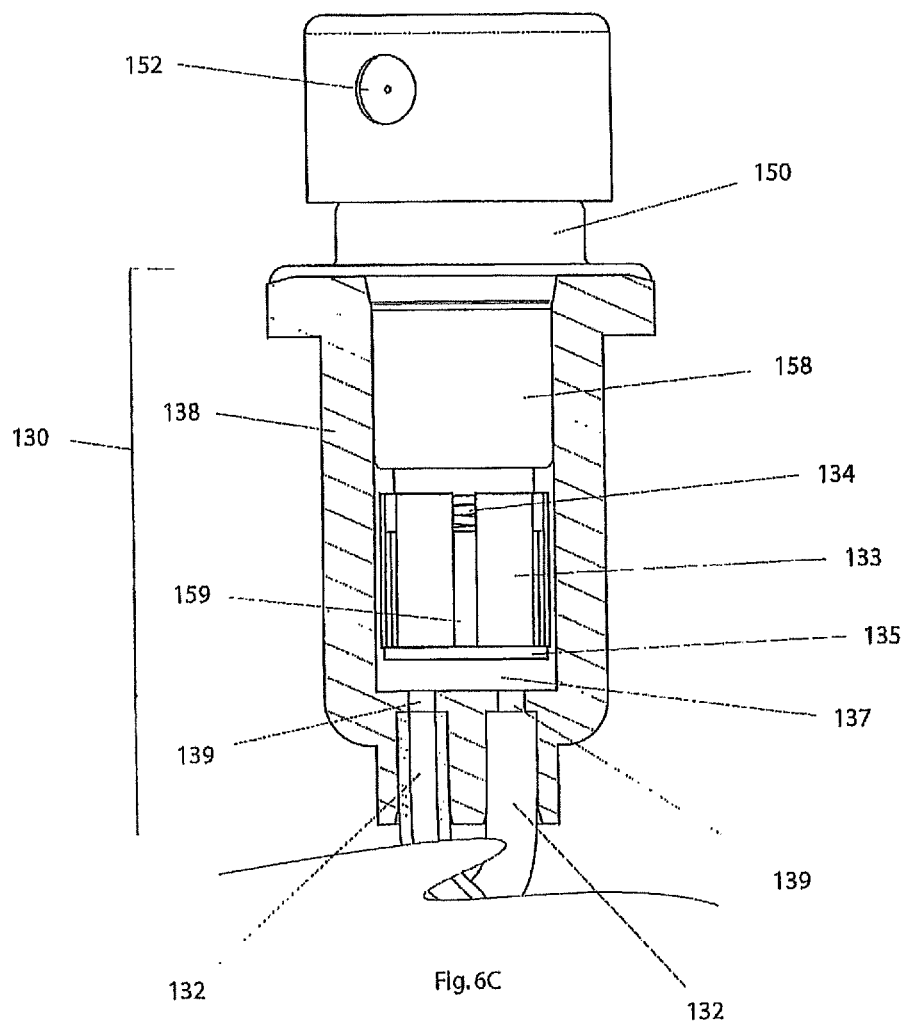


Fig. 6B



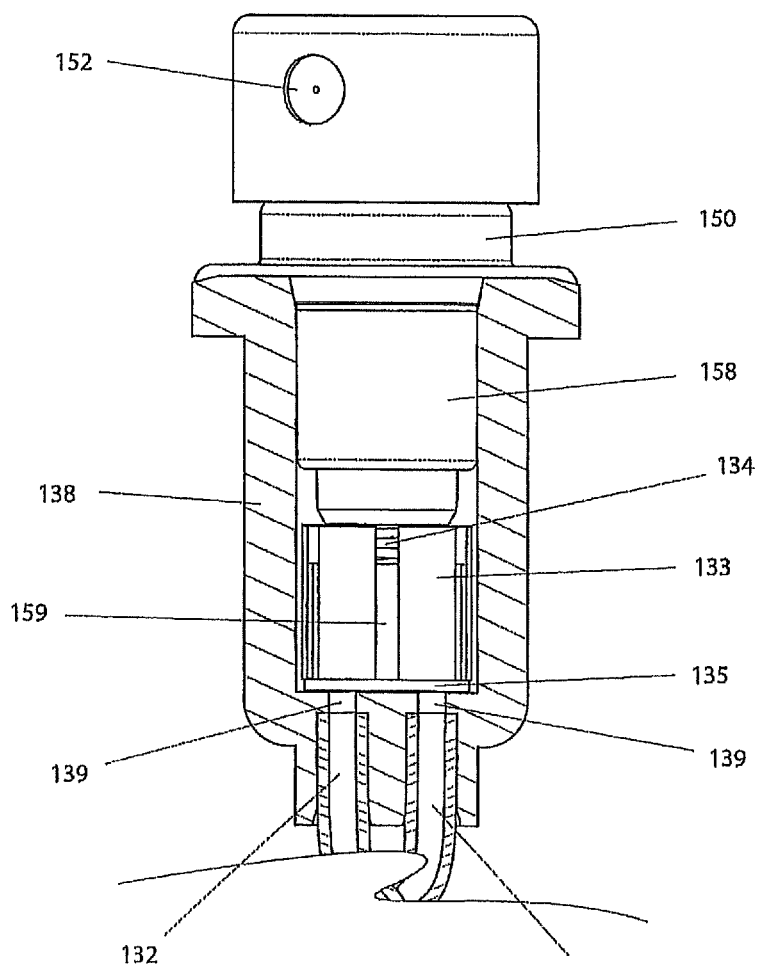
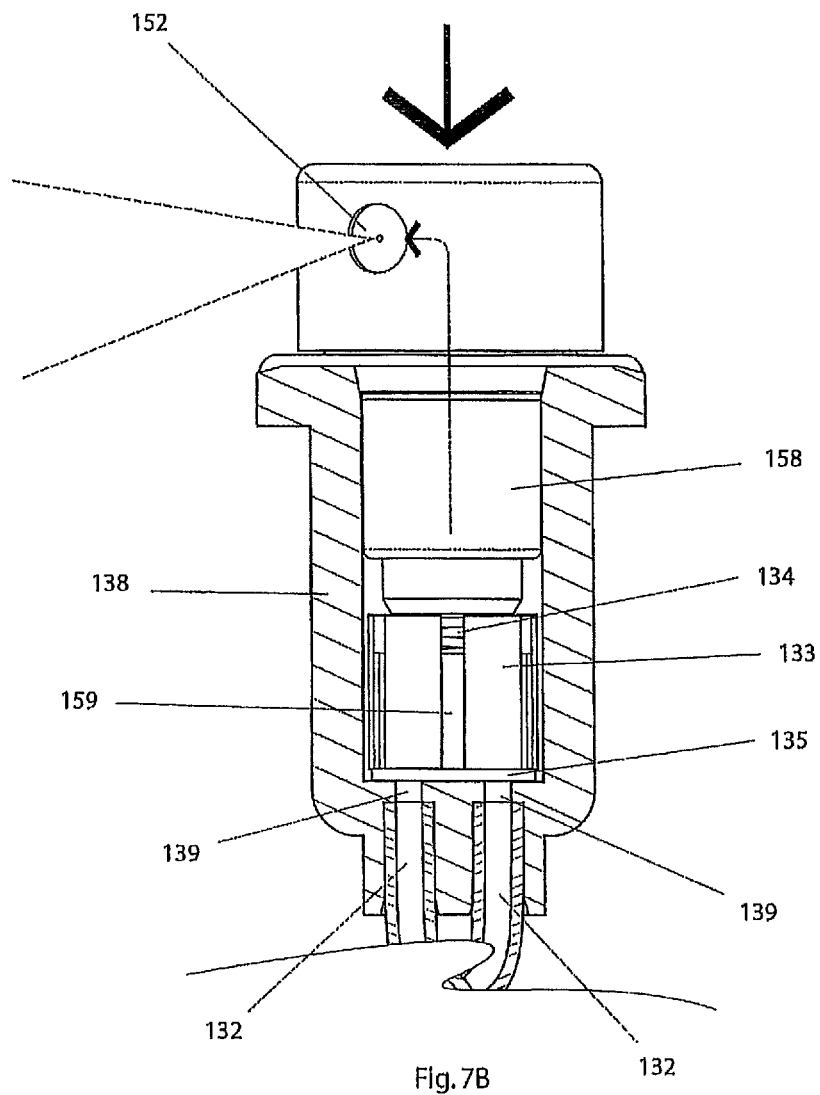


Fig. 7A



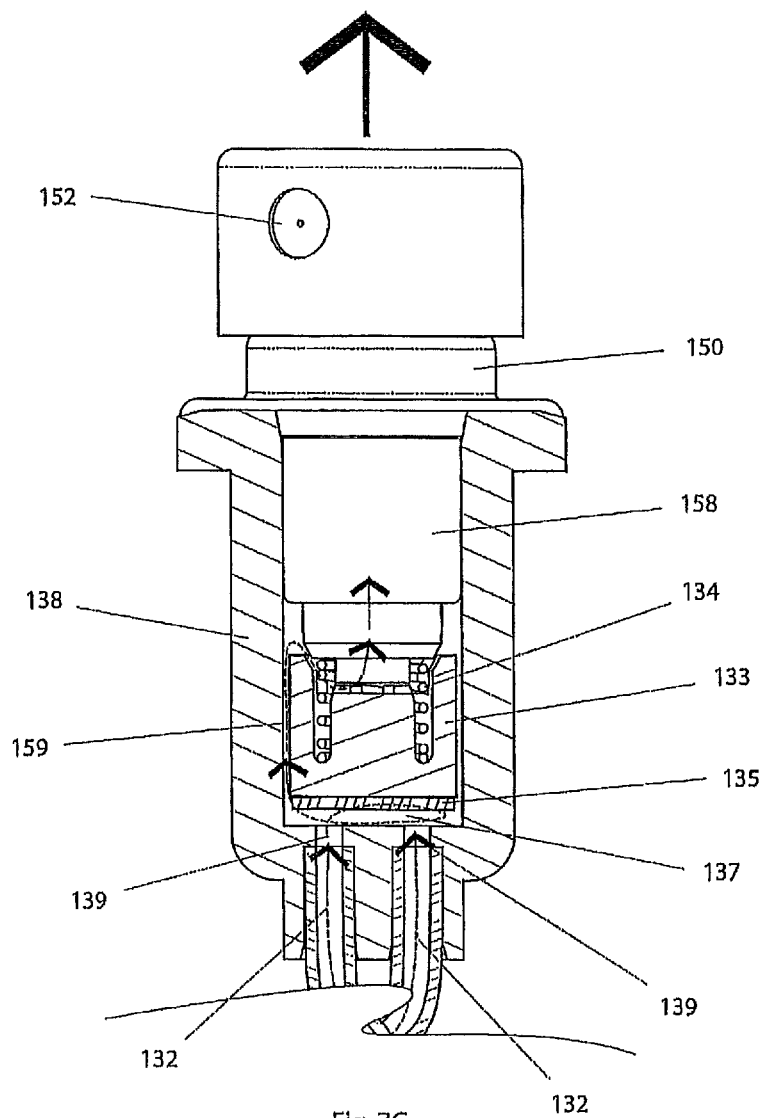
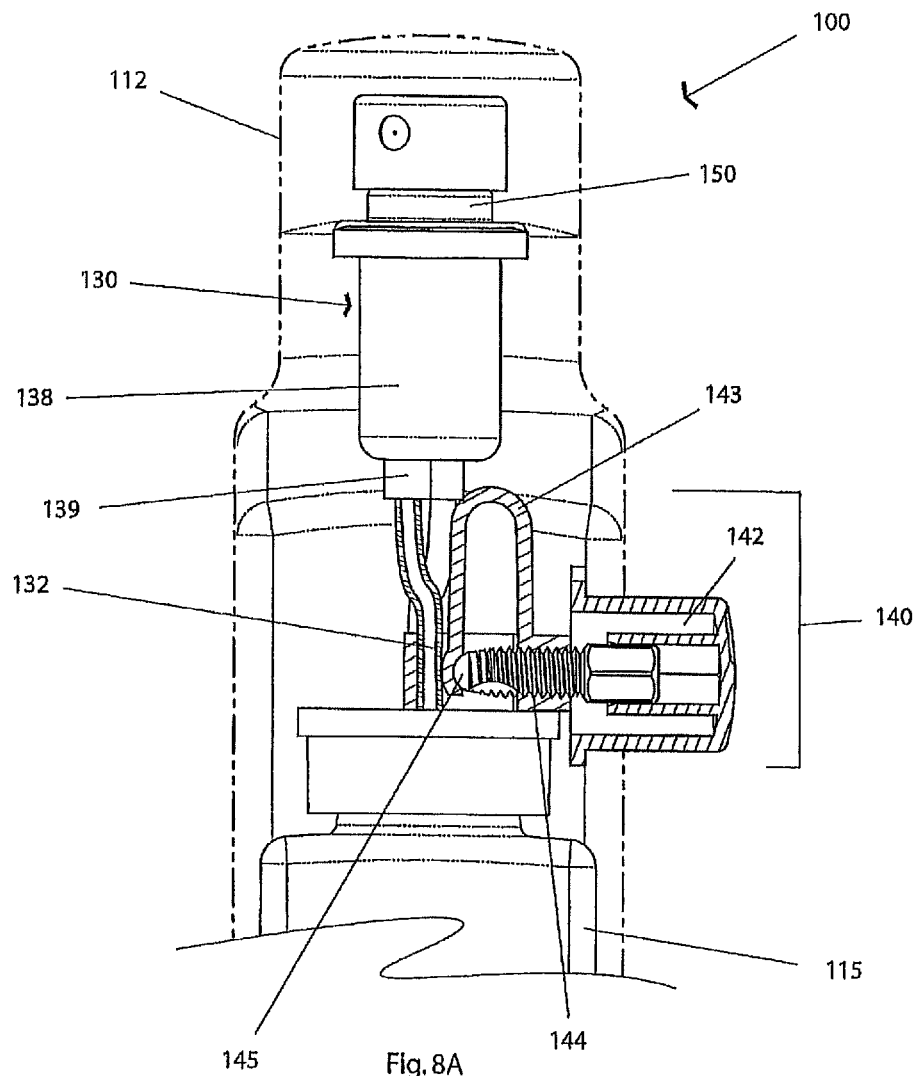
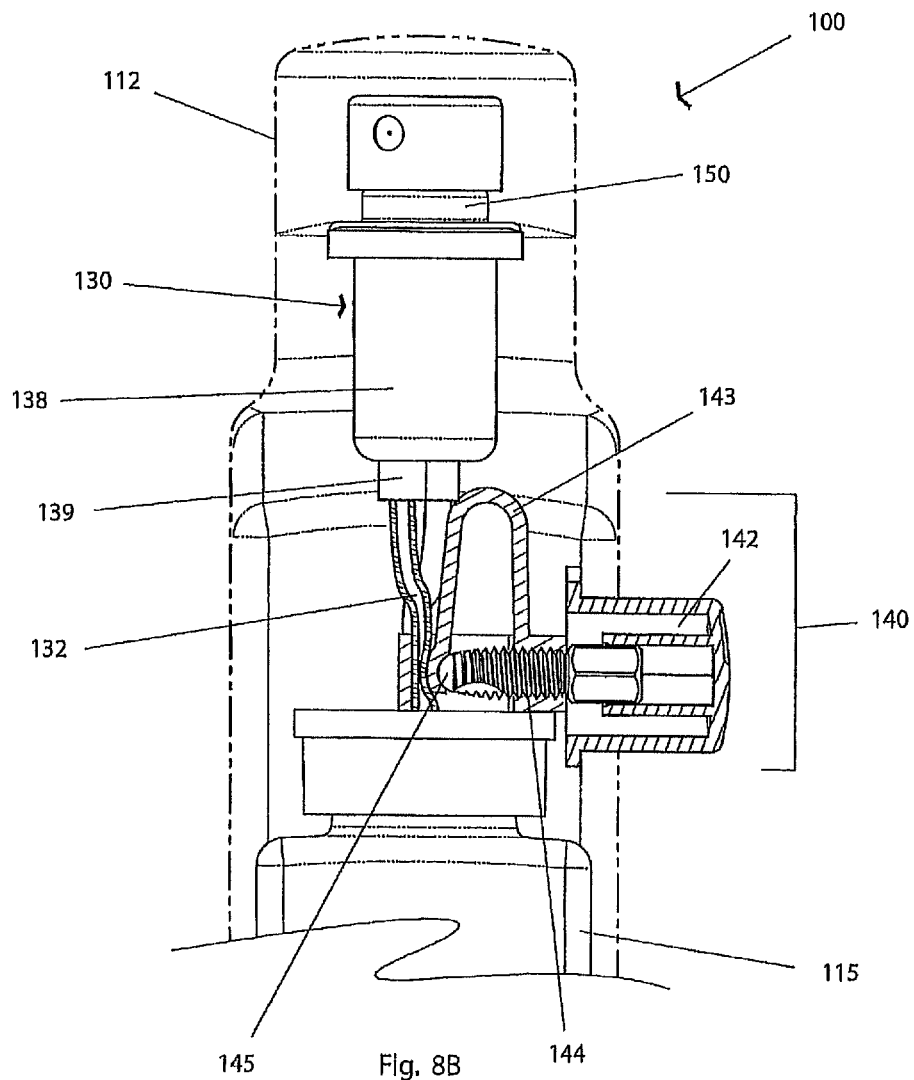


Fig. 7C





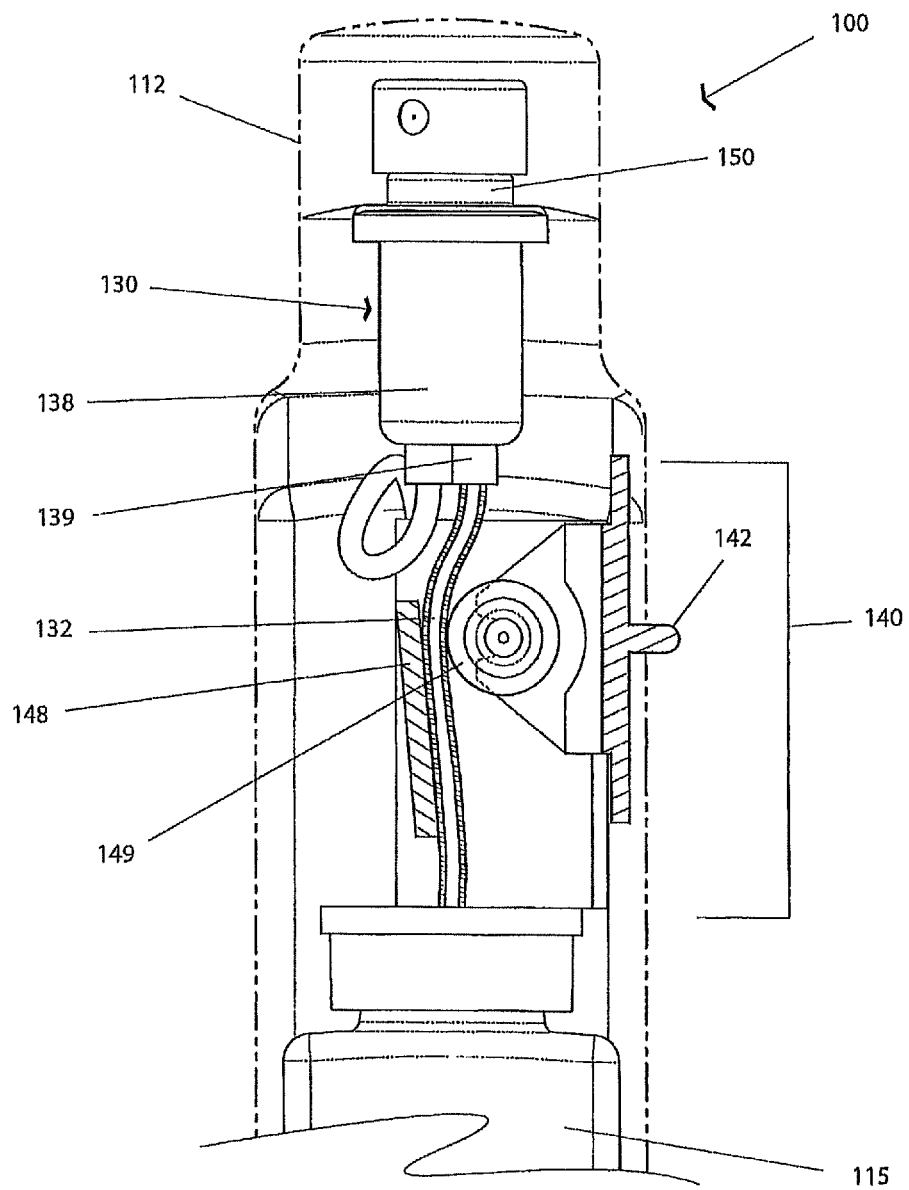


Fig. 9A

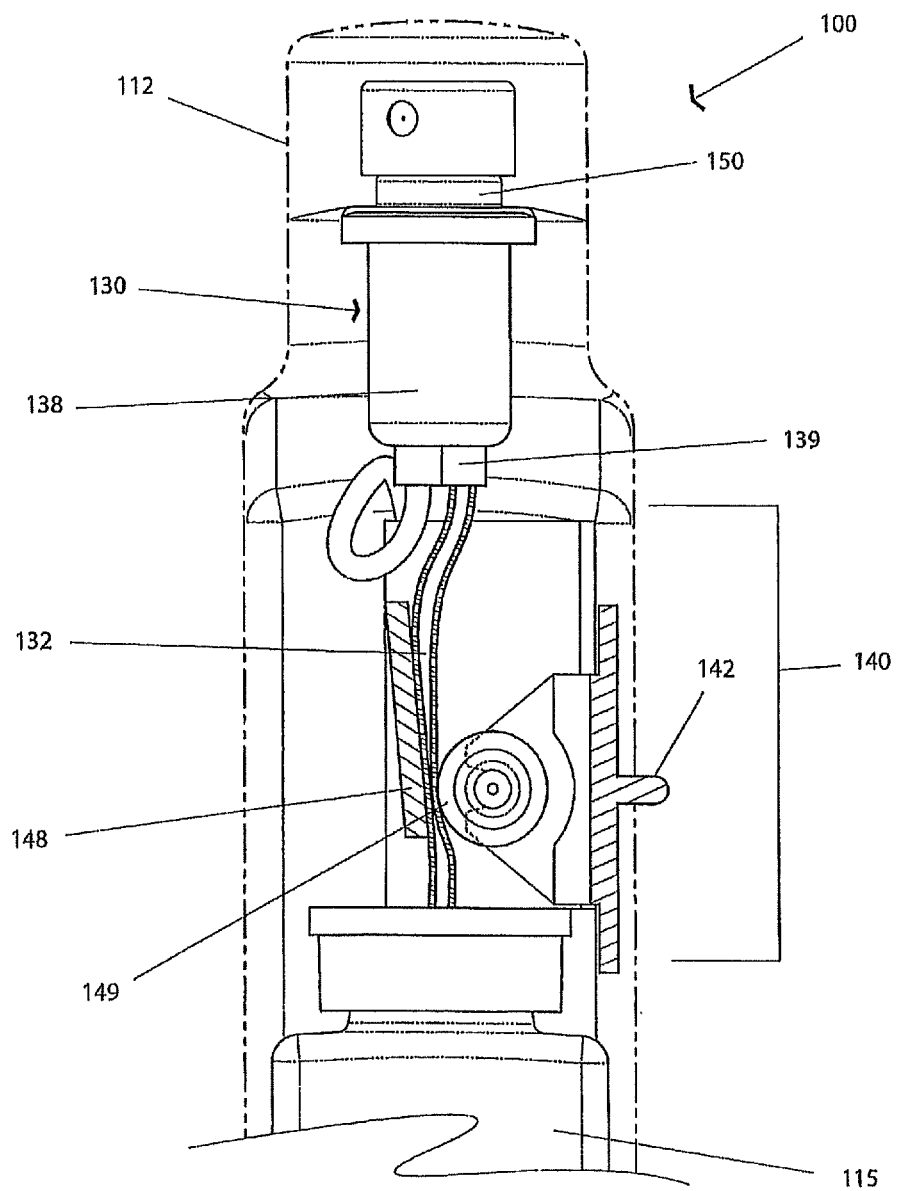


Fig. 9B

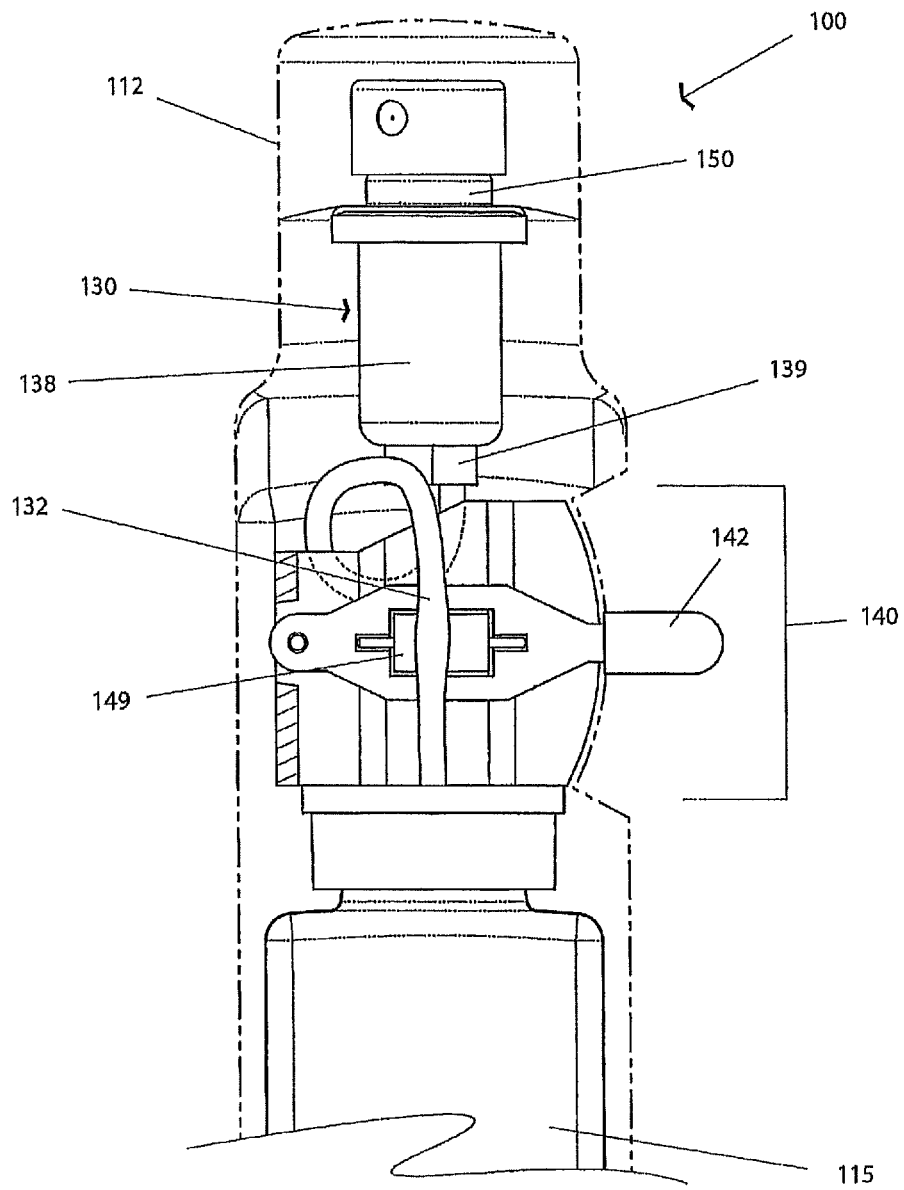


Fig. 10A

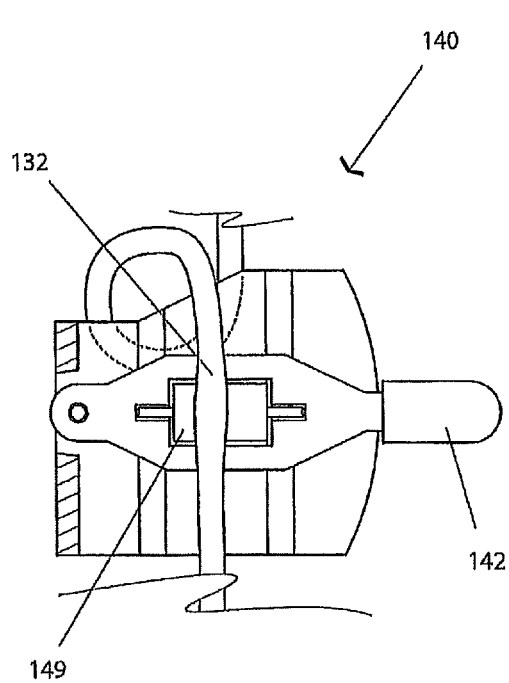


Fig. 10B

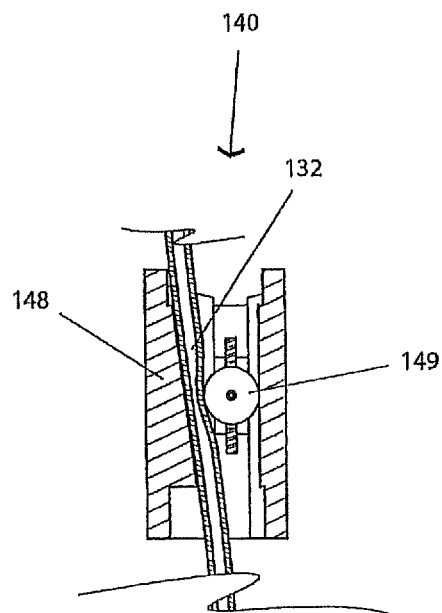


Fig. 10C

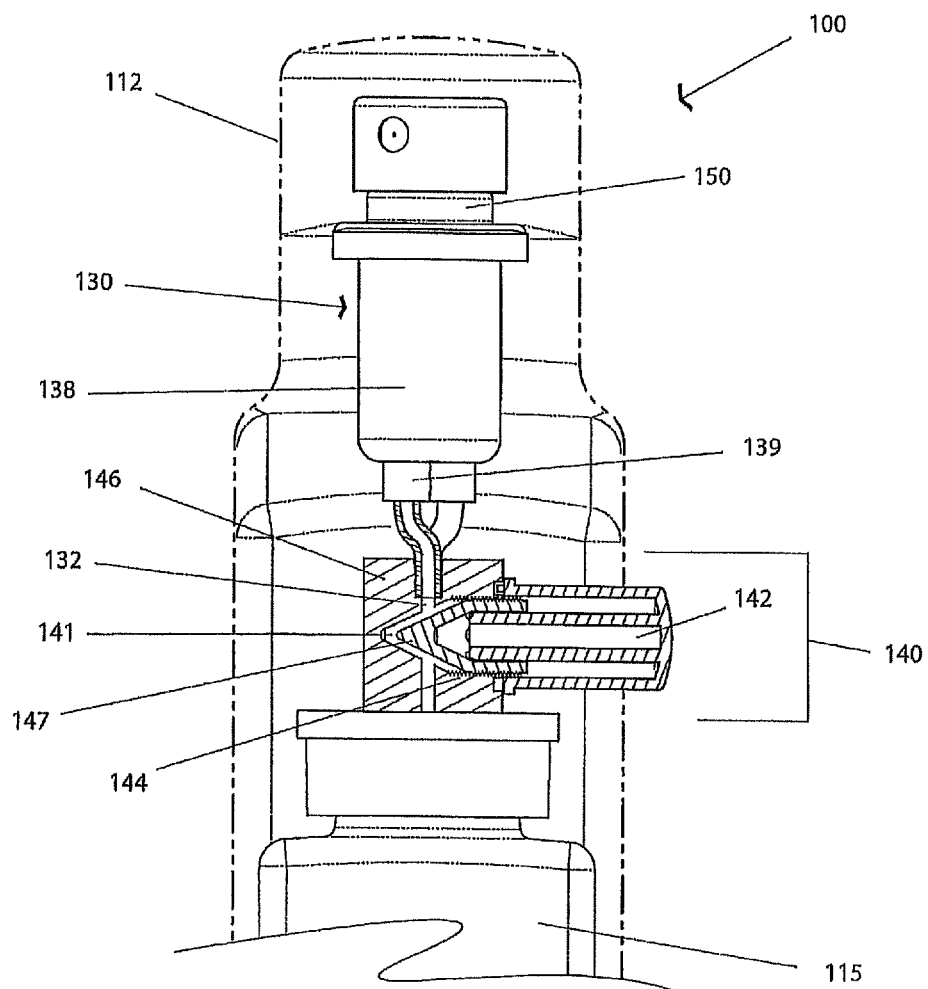


Fig. 11A

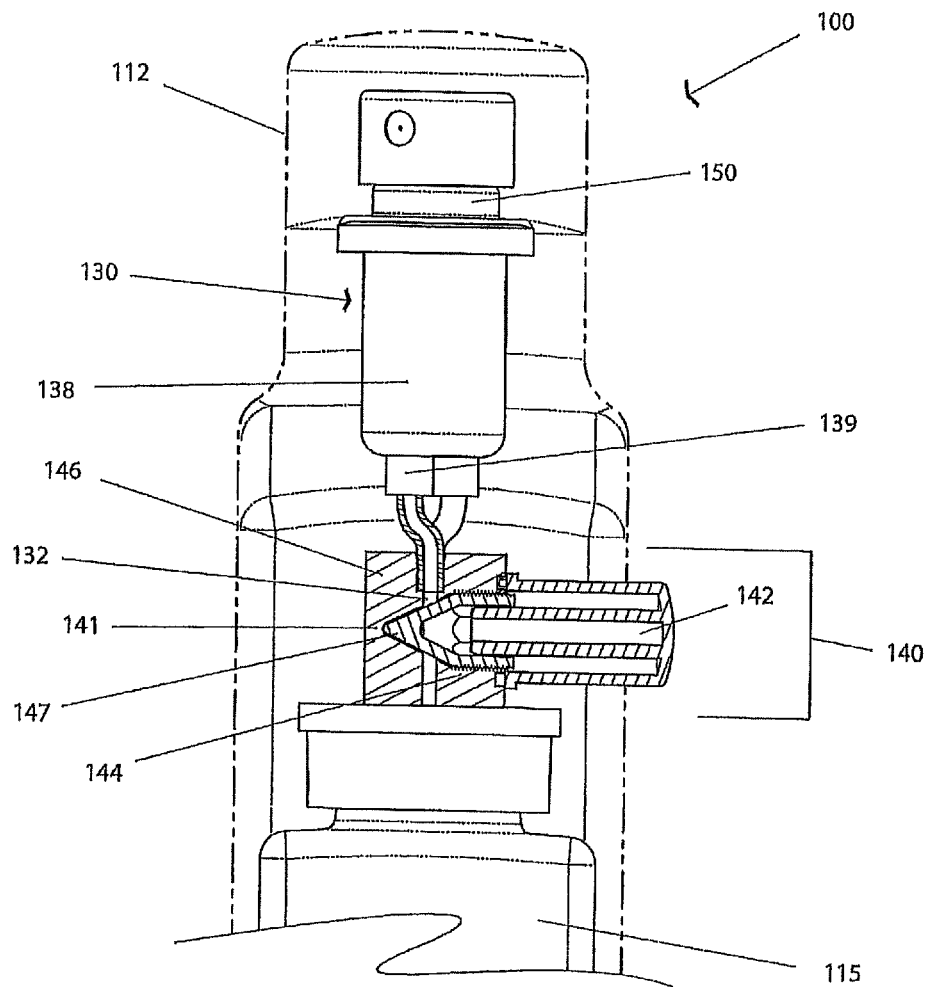
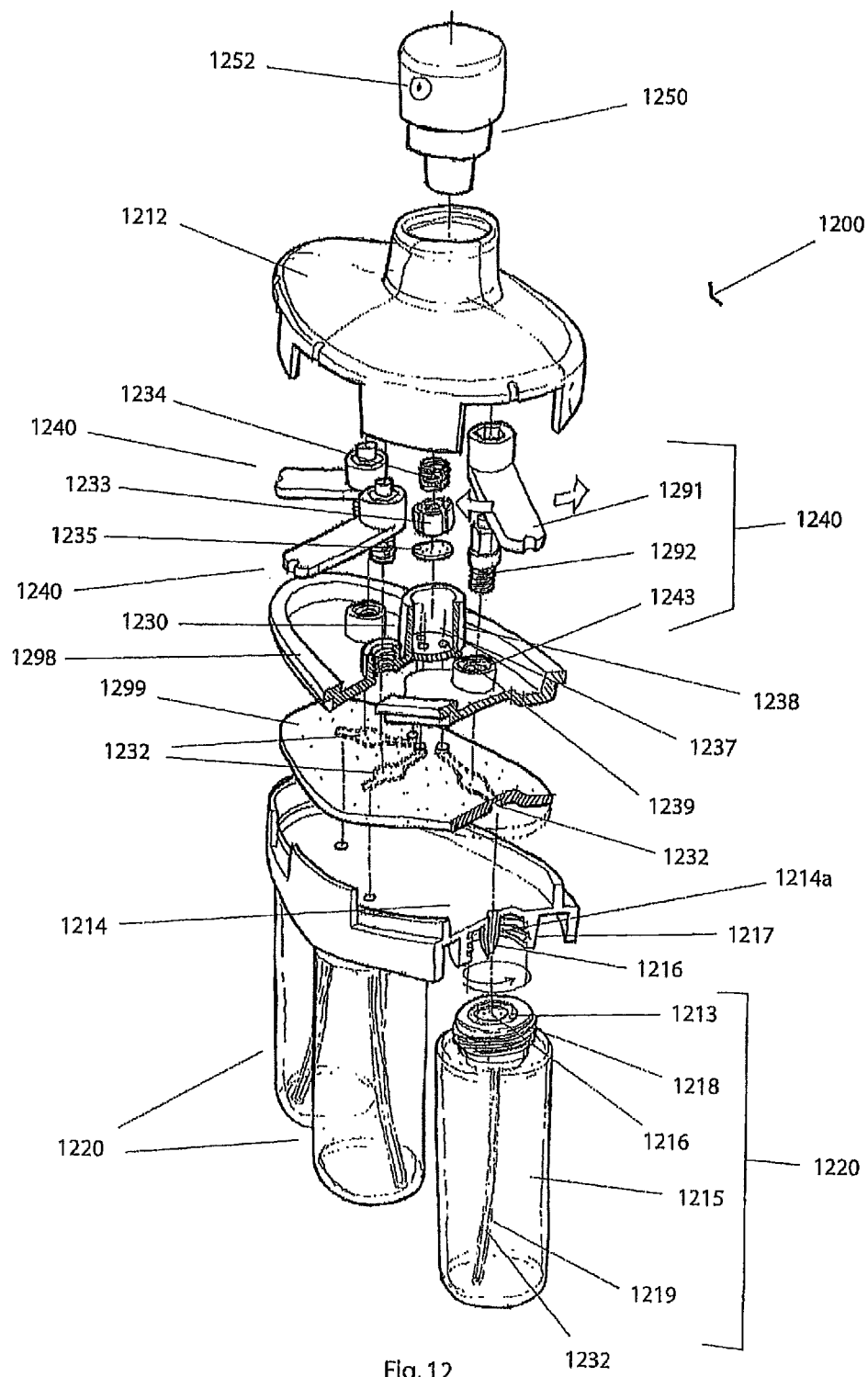


Fig. 11B



1

MIXING AND DISPENSING DEVICE**CROSS REFERENCE TO RELATED APPLICATIONS**

This application claims priority to U.S. patent application Ser. No. 13/462,461, filed May 2, 2012, which claims priority to U.S. Provisional Application No. 61/481,553, filed May 2, 2011, and U.S. Provisional Application No. 61/560,560, filed Nov. 16, 2011, both of which are incorporated herein by reference.

BACKGROUND

Various devices are known in the art to dispense fluids. Typically, dispensers hold a single fluid, however, it is often desirable for multiple fluids to be stored in separate storage containers within a single device, and then mixed and immediately dispensed as a mixture from the device. In various industries, including the fragrance industry, it is desirable to have a device that is configured to proportionally adjust the volumetric ratio of each fluid that comprises the mixture, in order to provide a customized fragrance or product that includes each of a plurality of fluids.

SUMMARY

In an embodiment, a device for mixing a plurality of fluids to formulate a mixture and for dispensing the mixture is disclosed. The device comprises a plurality of cartridge assemblies each comprising a cartridge configured to contain one of the plurality of fluids. There is a plurality of flow channels each having a central axis and each configured to communicate with a corresponding one of the cartridges. A plurality of valve assemblies is each positioned to communicate with one of the flow channels to adjust a mass flow rate of the fluid drawn from the corresponding cartridge. There is a manifold assembly positioned downstream to the valve assembly. The manifold assembly comprises a manifold body having a mixing chamber and a plurality of inlets each configured to communicate with a corresponding one of the flow channels through which the fluid from the cartridge of the corresponding cartridge assembly is drawn into the mixing chamber during operation of the device. The manifold assembly also has a seal disposed within the manifold, body adjacent to and having a size and a shape that substantially covers the inlets. The manifold assembly has a spring disposed within the manifold body and a piston disposed within the manifold body between the seal and the spring. The spring is moveable between an extended position in which the spring engages the piston to move the seal to a closed position that substantially and simultaneously closes the inlets from the flow channels and a compressed position that moves the seal away from the inlets to substantially and simultaneously open the inlets to the flow channels. The device also has a dispensing pump assembly configured to communicate with the manifold assembly and configured to draw fluid from each of the cartridge assemblies. A nozzle is configured to communicate with the dispensing pump assembly and to dispense the mixture. During operation the dispensing pump draws a volume of fluid from each cartridge through the corresponding flow channel and through the corresponding inlet into the mixing chamber to form the mixture. The mixture is drawn from the mixing chamber through the dispensing pump to the nozzle.

In another embodiment, a device for mixing a plurality of fluids to form a mixture and for dispensing the mixture is

2

disclosed. The device has a plurality of cartridges each configured to contain one of the plurality of fluids. A plurality of flow channels each have a central axis and are each configured to communicate with a corresponding one of the cartridges. A plurality of independently adjustable valves are each positioned adjacent to one of the flow channels and are each adjustable along a second axis that is not parallel to the central axis to adjust a mass flow rate of the fluid drawn from the corresponding cartridge. A manifold body has a plurality of inlets each configured to communicate with a corresponding one of the flow channels through which the fluid from the corresponding cartridge is drawn into a mixing chamber during operation. A seal is disposed within the manifold body adjacent to and sized to substantially cover the inlets. A piston is disposed within the manifold body between the seal and a spring, wherein the spring is moveable between an extended position in which the spring engages the piston to move the seal to a closed position that substantially and simultaneously closes the inlets from the flow channels and a compressed position that moves the seal away from the inlets to substantially and simultaneously open the inlets to the flow channels. A dispensing pump is configured for communication with the mixing chamber and is configured to draw fluid from each of the cartridges. A nozzle is configured for communication with the dispensing pump and is configured to dispense the mixture. During operation the dispensing pump draws a volume of fluid from each cartridge through the corresponding flow channel and through the corresponding inlet into the mixing chamber to form the mixture. The mixture is drawn from the mixing chamber through the dispensing pump to the nozzle.

In another embodiment, a device for mixing a plurality of fluids to form a mixture and for dispensing the mixture is disclosed. There is a plurality of cartridge assemblies, each cartridge assembly comprising cartridge configured to contain one of the plurality of fluids and a plurality of flow channels. Each flow channel has a lumen having a cross-sectional area, a central axis, and is configured to communicate with a corresponding one of the cartridges, wherein the cross-sectional area of each flow channel is directly proportional to a mass flow rate of fluid drawn from the corresponding cartridge during operation of the device. The device has a manifold assembly that has a manifold body having a mixing chamber and a plurality of inlets each configured to communicate with a corresponding flow channel through which the fluid from the cartridge of the corresponding cartridge assembly is drawn into the mixing chamber during operation. A seal is disposed within the manifold body adjacent to and sized to substantially and simultaneously close the inlets. A spring is disposed within the manifold body. A piston is disposed within the manifold body between the seal and the spring. The spring is moveable between an extended position in which the spring engages the piston to move the seal to a closed position that substantially and simultaneously closes the inlets from the flow channels and a compressed position that moves the seal away from the inlets to substantially and simultaneously open the inlets to the flow channels. A dispensing pump assembly is configured for communication with the manifold assembly and is configured to draw fluid from each of the cartridge assemblies. A nozzle is configured for communication with the dispensing pump assembly and is configured to dispense the mixture. During operation the dispensing pump draws the volume of fluid from each cartridge assembly through the corresponding inlet into the mixing chamber to form the mixture. The mixture is drawn from the mixing chamber through the dispensing pump to the nozzle.

3

Other objects, features, aspects and advantages of the mixing and dispensing device will become better understood or apparent from the following detailed description, drawings, and appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an embodiment of a mixing and dispensing device illustrating a cartridge and valve assemblies in a linear array, showing (A) a front isometric view and including dashed arrows that illustrate the flow of fluid through the device when the device is in operation, (B) a rear isometric view, (C) a side elevation view, (D) an exploded view, (E) an exploded detail view of a valve, (F) an isometric detail view of a cartridge, (G) a cross-sectional view of a cartridge, (H) an exploded view of a cartridge, (I) an cross-sectional view of a cartridge with a bladder, and (J) an exploded view including a purging assembly;

FIG. 2 is another embodiment of the mixing and dispensing device illustrating the cartridge and valve assemblies in a radial array, showing (A) a front isometric view and including dashed arrows that illustrate the flow of fluid through the device when the device is in operation, (B) a rear isometric view, and (C) a side elevation view;

FIG. 3 is another embodiment of the mixing and dispensing device illustrating inverted cartridge assemblies, showing (A) a front isometric view, (B) a rear isometric view, (C) a side elevation view and including dashed arrows that illustrate the flow of fluid through the device when the device is in operation, (D) an exploded view, (E) a cross-sectional view through an inverted cartridge in combination with the spike plate and showing the cartridge detached from the spike plate, and (F) a cross-sectional view through an inverted cartridge in combination with the spike plate and showing the cartridge attached to the spike plate;

FIG. 4 is another embodiment of the mixing and dispensing device illustrating flow channels having lumens of differing cross-sectional areas, showing (A) a front isometric view and including dashed arrows that illustrate the flow of fluid through the device when the device is in operation, (B) a rear isometric view, (C) a side elevation view, and (D) an exploded view;

FIG. 5 is an embodiment of the manifold assembly, showing (A) an isometric view with the manifold body shown transparent for clarity, (B) an exploded isometric view, and (C) a manifold body having inlets in the sidewall;

FIG. 6 is an orthographic front view of an embodiment of the manifold assembly illustrated in FIG. 5 (with the manifold body shown in cross-section for clarity) in combination with a dispensing pump and nozzle, and illustrating (A) the seal in the fully closed position, (B) horizontal cross-sectional views of the manifold assembly taken along lines 6aa, 6ab, and 6ac shown in FIG. 6A, and (C) the seal in the fully opened position;

FIG. 7 illustrates an orthographic front view of an embodiment of the manifold assembly (with the manifold body shown in cross-section for clarity), dispensing pump, and nozzle (A) in a resting state, (B) in an actuated state, and (C) in a rebound state;

FIG. 8 is a partial cross-sectional view of the mixing and dispensing device shown in FIG. 1 taken through the valve assembly and showing a screw-actuated pinch valve in (A) the fully opened position and (B) the fully closed position;

FIG. 9 is a partial cross-sectional view of an embodiment of a mixing and dispensing device taken through the valve assembly and showing a slider-actuated pinch valve in (A) the fully opened position and (B) the fully closed position;

4

FIG. 10 is (A) a partial cross-sectional view of an embodiment of a mixing and dispensing device taken through the valve assembly and showing a lever-arm actuated pinch valve in a partially opened position, (B) a partial cross-sectional side view detail through the lever-arm actuated pinch valve in a partially opened position, and (C) a rear view detail cross-sectional view through a lever-arm actuated pinch valve in a partially opened position;

FIG. 11 is a partial cross-sectional view of an embodiment of a mixing and dispensing device taken through the valve assembly and showing a needle valve in (A) the fully opened position and (B) the fully closed position; and

FIG. 12 is an exploded view of another embodiment of the mixing and dispensing device illustrating the cartridge and valve assemblies in a non-linear array.

DETAILED DESCRIPTION

As shown generally in the Figures, embodiments of a device 100, 200, 300, 400, 1200 for mixing a plurality of fluids to formulate a mixture and dispensing the mixture are disclosed. As shown in FIGS. 1 to 4 and 12, the device 100, 200, 300, 400, 1200 has at least two cartridge assemblies 120, 220, 320, 420, 1220 positioned relative to each other in a linear (FIGS. 1, 3, 4), radial (FIG. 2), or non-linear (FIG. 12) array. Each cartridge assembly 120, 220, 320, 420, 1220 has a cartridge 115, 215, 315, 415, 1215 that is configured to hold a fluid. In various embodiments, the fluid in each cartridge 115, 215, 315, 415, 1215 is a fragrance oil, a solvent, a pigment, an ink, a dye, a medication, a dietary supplement, a flavoring, spirits, a cleaning substance, or any other such substance available in a liquid form. The device 100, 200, 300, 400, 1200 has at least two flow channels 132, 232, 332, 432, 1232 each associated with a corresponding cartridge 115, 215, 315, 415, 1215. Embodiments (FIGS. 1-3, 12) have adjustable valve assemblies 140, 240, 340, 1240 configured to adjust a mass flow rate of fluid from each cartridge 115, 215, 315, 1215. The flow channels 132, 232, 332, 1232 are configured to communicate with a manifold assembly 130, 230, 330, 1230. In the embodiments illustrated in FIGS. 1-3 and 12, the manifold assembly 130, 230, 330, 1230 is positioned downstream from the adjustable valve assemblies 140, 240, 340, 1240. Referring again generally to the Figures, a dispensing pump assembly 150, 250, 350, 450, 1250 is positioned downstream from the manifold assembly 130, 230, 330, 430, 1230 and is configured to communicate with a nozzle 152, 252, 352, 452, 1252 that is positioned downstream from the dispensing pump 150, 250, 350, 450, 1250. In the embodiments illustrated in FIGS. 1-3 and 12, the fluid communication between each cartridge 115, 215, 315, 1215, its corresponding flow channel 132, 232, 332, 1232, and the manifold assembly 130, 230, 330, 1230 is adjustable by the corresponding valve assembly 140, 240, 340, 1240. Referring again to FIGS. 1-4 and 12, the manifold assembly 130, 230, 330, 430, 1230, dispensing pump assembly 150, 250, 350, 450, 1250 and nozzle 152, 252, 352, 452, 1252 are in fluid communication with each other when the dispensing pump assembly 150, 250, 350, 450, 1250 is actuated.

During operation, the device 100, 200, 300, 400, 1200 is configured to formulate a mixture of a plurality of fluids in the manifold assembly 130, 230, 330, 430, 1230 where each fluid is drawn through a corresponding flow channel 132, 232, 332, 432, 1232 to a mixing chamber 137, 237, 337, 437, 1237 disposed within the body 138, 238, 338, 438, 1238 of the manifold assembly at a mass flow rate that may be proportional to a preset volumetric ratio. The mixture of the plurality of fluids is drawn into the dispensing pump assembly 150,

5

250, 350, 450, 1250 from which it is subsequently expelled through the nozzle 152, 252, 352, 452, 1252. In embodiments of the device 100, 200, 300, 1200 such as those illustrated in FIGS. 1-3 and 12, the volumetric ratio of each fluid comprising the mixture is adjusted by an adjustable valve 140, 240, 340, 1240 that independently adjusts the mass flow rate of each one of the fluids that is drawn from each cartridge through the corresponding flow channel during operation of the device. In another embodiment of the device 400 illustrated in FIG. 4, the volumetric ratio of each fluid comprising the mixture is directly proportional to the cross-sectional area of a lumen of each flow channel 432, which determines the mass flow rate of the fluid therethrough during operation of the device 400. Referring generally to the Figures, the result of operation of the device 100, 200, 300, 400, 1200 is the expulsion of a customized mixture from the nozzle 152, 252, 352, 452, 1252.

When referring to the embodiments illustrated in FIG. 1, the device is designated as 100 with the corresponding reference numbers for component parts indicated in the 100 series, while the embodiment illustrated in FIG. 2 is designated as device 200 with the corresponding reference numbers for component parts indicated in the 200 series. For example, the cartridge assembly of device 100 is designated 120 while the cartridge assembly of device 200 is designated 220. Devices 100, 200 are described together in the following description because the devices 100, 200 differ only in the configuration of the cartridge assemblies 120, 220 relative to each other and the resulting configuration of inlets 139, 239.

In embodiments of the device 100, 200 illustrated in FIGS. 1, 2, respectively, the device 100, 200 has at least two cartridge assemblies 120, 220 each comprising a cartridge 115, 215. At least two flow channels 132, 232 are each configured to communicate with an interior of a corresponding one of the cartridges 115, 215. The device 100, 200 has at least two adjustable valve assemblies 140, 240 each positioned to communicate with a corresponding one of the flow channels 132, 232 to adjust a mass flow rate of fluid that is drawn by the dispensing pump assembly 150, 250 from the corresponding cartridge 115, 215 through the flow channel 132, 232 each time the dispensing pump assembly 150, 250 rebounds to its resting state. By way of example, positioned to communicate includes positioned adjacent to the corresponding flow channel 132, 232 (e.g., FIGS. 8-10) or positioned within the lumen of the corresponding flow channel 132, 232 (e.g., FIG. 11). Referring again to FIGS. 1, 2, the device 100, 200 has a manifold assembly 130, 230 positioned downstream from the adjustable valve assembly 140, 240 and a dispensing pump assembly 150, 250 positioned downstream from the manifold assembly 140, 240. The dispensing pump assembly 150, 250 is configured to communicate with a downstream nozzle 152, 252.

Optionally, the cartridge assemblies 120, 220, flow channels 132, 232, adjustable valve assemblies 140, 240 (except for the moveable control), manifold assembly 130, 230, and dispensing pump assembly 150, 250 are enclosed in a body 112, 212. In embodiments, the body 112, 212 is comprised of a single component or multiple components. In an embodiment, a portion of the body 112, 212 is removable or is configured to open or close to provide or restrict access, respectively, to the cartridges, for example, as useful to remove and replace a cartridge. Body 112, 212 may be made of plastic, such as injection molded polycarbonates, polystyrenes, etc.

As illustrated in FIG. 1D, each cartridge assembly 120 includes a cartridge 115 and a cartridge receptacle 117 configured to receive a neck of cartridge 115. In an example, the

6

neck and the cartridge receptacle 117 are configured to threadably engage. In another example, the cartridge 115 is snap-fit into the cartridge receptacle 117. Optionally, the cartridge assembly 120 includes a spike plate 114. The spike plate 114 is configured to communicate with the interior of a corresponding cartridge 115 such as for example by a port 114a in the spike plate 114 or by a coupling (not shown) attached to or integral with the spike plate 114 that has a distal end that pierces the closure device (described below) of the cartridge and a proximal end that communicates with the corresponding flow channel 132. Cartridge assembly 220 is the same as described herein with respect to cartridge assembly 120 in connection with FIG. 1D. One skilled in the art will appreciate that spike plate 114, port 114a, and cartridge receptacle 117 may be unitary components, such as an integrally injection molded part, or assembled parts.

Referring again generally to FIGS. 1 and 2, in an embodiment, each cartridge 115, 215 is removable and replaceable. In another embodiment, each cartridge 115, 215 is permanently affixed onto or within the body 112. The cartridges 115, 215 may be of differing or the same volume capacity, length, or diameter. In embodiments, the cartridges 115, 215 are made from, by way of example, glass, plastic, metallic materials, collapsible or pliable materials such as a bladder, or materials that are resistant to degradation by the fluids contained or to be contained therein. In an embodiment, the cartridges 115, 215 are clear to render the fluid contents visible. Optionally, a window (not shown) is positioned in a wall of an opaque cartridge to show the fluid contents thereof.

As illustrated in FIGS. 1, 2, and particularly in FIG. 1D, each cartridge 115, 215 has a closure device 118, 218, such as a cap, seal, or the like that substantially closes the cartridge 115, 215 so that the fluid contained therein does not leak out. The closure device 118, 218 is either integral with the cartridge 115, 215 or assembled. A port 116, 216, optionally positioned in or integral with the closure device 118, 218, provides communication between the interior of cartridge 115, 215 and the corresponding flow channel 132, 232 when the port 116, 216 is in the opened position. Port 116, 216 is in the closed position when the cartridge 115, 215 is disconnected from the cartridge assembly 120, 220. As illustrated in FIG. 1D, the port 116 is configured to receive a distal end of the corresponding flow channel 132 or a coupling (not shown), such as a spike, needle, nipple, zirk, or other such connector, that connects or couples the distal end of the corresponding flow channel 132 to the interior of the cartridge 115. In an embodiment, the port 116 is a pierceable septum.

Each cartridge 115, 215 has a vent 113 (see FIGS. 1D, 1F, 1G, 1H) that is configured for entry of atmospheric air into the cartridge 115, 215 as fluid is removed by the dispensing pump 150, 250. The vent 113 substantially eliminates the buildup of vacuum in the cartridge 115, 215. The vent 113 is configured to substantially prevent leakage of the fluid from the cartridge 115, 215. Optionally, the vent 113 is positioned within or is integral with the closure device 118, 218 or the port 116, 216. By way of example, the vent 113 is an elastomeric duck-bill valve, a flapper valve, an umbrella valve, a diaphragm, etc. In another example, the vent 113 is a spring-loaded assembly such as a ball or ball plunger that engages a sealing aperture.

Optionally, as illustrated in FIG. 1I, a bladder 193 is positioned in the interior of the cartridge 115 and is configured to hold the fluid. The port 116 is in communication with the interior of the bladder 193. In embodiments, the bladder 193 is at least one of flexible, removable, replaceable, and refillable.

Optionally, as illustrated in FIG. 1D, a conduit 119, such as a sipper tube, is included in each cartridge 115. The conduit

7

119 is configured to draw fluid from the interior of the cartridge 115 and to communicate with the distal end of the corresponding flow channel 132. As illustrated in FIGS. 1 and 2, a flow channel 132, 232 is in communication with the interior of a corresponding cartridge 115, 215 either directly or via connection to coupling (not shown). Each flow channel 132, 232 transports the fluid from the corresponding cartridge 115, 215 to the mixing chamber 137, 237 of the manifold 130, 230 when the dispensing pump assembly 150, 250 is rebounding. Each flow channel 132, 232 has proximal and distal ends, a central axis, and a lumen that has a cross section. In an embodiment, the port 116, 216 of the cartridge 115, 215 receives a distal end of the corresponding flow channel 132, 232. In another embodiment, the port 116, 216 receives a distal end of coupling that is connected to the distal end of the corresponding flow channel 132, 232.

As shown in FIGS. 1, 2, and 5-11, the proximal end of each flow channel 132, 232 is in communication with one of the inlets 139, 239 of the manifold 130, 230. In an embodiment, the flow channel 132, 232 is compressible or pliable, such as an elastomeric material made of, for examples, extruded PVC, silicone, etc. In another embodiment, the flow channel 132, 232 is made of a semi-rigid or rigid material.

As illustrated in FIGS. 1, 2, and 8-11, in an embodiment, an adjustable valve assembly 140, 240 is positioned to communicate with a corresponding flow channel 132, 232. Each adjustable valve assembly 140, 240 may be controlled independently from other adjustable valve assemblies 140, 240 in the device 100, 200. Each adjustable valve assembly 140, 240 may function independently from other adjustable valve assemblies in the device. The adjustable valve assembly 140, 240 adjusts a mass flow rate of fluid that is drawn by the dispensing pump assembly 150, 250 from the corresponding cartridge 115, 215 through the flow channel 132, 232 each time the dispensing pump assembly 150, 250 rebounds. Each adjustable valve assembly 140, 240 has a moveable control 142, 242 that is configured for use by a user to adjust the adjustable valve assembly 140, 240 to a position that adjusts the mass flow rate of fluid from a corresponding cartridge 115, 215 through the adjacent flow channel 132, 232 when the device 100, 200 is in operation. The moveable control 142, 242 is, for examples, a rotary knob or screw (FIGS. 1, 2, 8), a slider switch (FIG. 9), or a lever arm (FIG. 10). This list is not intended to be inclusive however, and the moveable control 142, 242 can be anything known by those skilled in the art to be functional in the device. Optionally, the moveable control 142, 242 has a scale or other indicator (not shown) that indicates the position of one adjustable valve assembly 140, 240 relative to the other adjustable valve assemblies, or the moveable control 142, 242 has incremental markings (not shown) that show the relative proportion of each fluid from each cartridge 115, 215 being mixed to form the mixture.

In an embodiment illustrated in FIGS. 8-10, the adjustable valve assembly 140 is positioned adjacent to the corresponding flow channel 132 and is adjustable along an axis that is not parallel to the central axis of the corresponding flow channel 132 at the point along the flow channel at which the adjustable valve 140 is adjacent thereto. The adjustable valve assembly 140 may be configured to progressively decrease a mass flow rate of fluid drawn from the corresponding cartridge 115 when the device is in use by progressively constricting the cross-sectional area of the corresponding flow channel 132 by progressively moving the movable control 142 to a position(s) that causes the adjustable valve 140 to progressively come into contact with an exterior surface of the flow channel 132 thereby constricting the cross-sectional area of the lumen of the flow channel 132 to decrease the mass flow

8

rate of fluid moving therethrough. Conversely, the mass flow rate of fluid that is drawn out of the cartridge 115, when the pump 150 is operational, is progressively increased by progressively moving the moveable control 142 to a position(s) that cause the adjustable valve to progressively retract from compressing an exterior surface of the flow channel 132, thereby causing the lumen of the flow channel 132 to rebound and restoring the cross-sectional area of the lumen to increase the mass flow rate of fluid moving therethrough. Examples of such an embodiment are illustrated in FIGS. 8-10, which illustrate a pinch valve (FIG. 8), a roller valve (FIG. 9), and a lever valve (FIG. 10). These examples are not intended to be limiting or inclusive, however, and any valve known to those skilled in the art is within the scope of this disclosure.

FIG. 8 illustrates a partial cross-sectional view of a device taken through the adjustable valve assembly 140 in which the adjustable valve assembly 140 is a screw-actuated pinch valve. The pinch valve 140 has a clamp 143 and a threaded shaft 144. The threaded shaft 144 has a tip 145. A control knob 142 mates with the threaded shaft 144 such that progressive axial rotation of the control knob 142 causes the threaded shaft 144 to progressively move axially towards or away from the clamp 143 to a closed (FIG. 8B) or an opened (FIG. 8A) position, respectively. In operation, the portion of the flow channel 132 between the cartridge 115 and the inlets 139 of the manifold body 138 is restricted by rotating the control knob 142 in a first direction to cause the threaded shaft 144 to move towards the clamp 143 until the clamp engages and at least partially compresses the flow channel 132 to constrict the cross-sectional area of the lumen of the flow channel 132 to decrease the mass flow rate of fluid through the flow channel 132. FIG. 8B illustrates the pinch valve 140 in the fully closed position. The fluid connection is restored by rotating control knob 142 in a second direction to cause the threaded shaft 144 to move away from and decompress the flow channel 132 to cause the lumen of the flow channel 132 to rebound, thereby at least partially restoring the cross-sectional area of the lumen and increasing the mass flow rate of fluid through the flow channel 132. FIG. 8A illustrates the pinch valve 140 in the fully opened position.

Referring to FIG. 9, a device 100 is illustrated in which the adjustable valve assembly 140 is a slide-actuated pinch valve. The pinch valve 140 has a ramp 148 and a roller 149. The flow channel 132 is positioned between the ramp 148 and the roller 149. The axis of the ramp 148 is positioned at an angle relative to the axis of movement of the roller 149. A slide switch control 142 mates with the roller 149 such that progressive linear movement of the slide switch 142 in a first direction causes the roller 149 to progressively move linearly across the ramp 148 from an open (FIG. 9A) to a closed (FIG. 9B) position to progressively compress the flow channel 132 between the roller 149 and the ramp 148 to constrict the cross-sectional area of the lumen of the flow channel 132 to progressively decrease the mass flow rate of fluid through the flow channel 132. Progressive linear movement of the slide switch 142 in a second direction causes the roller 149 to progressively decompress the flow channel 132 between the roller 149 and the ramp 148 to cause the cross-sectional area of the lumen of the flow channel 132 to rebound to progressively increase the mass flow rate of fluid through the flow channel 132.

Referring to FIG. 10, a device is illustrated in which the adjustable valve 140 is a lever-arm actuated pinch valve. The pinch valve 140 has a roller 149 and a ramp 149. The flow channel 132 is positioned between the ramp 148 and the roller 149. A lever arm control 142 pivotally mates with the roller 149 such that progressive pivoting of the lever arm 142 causes

the roller **149** to progressively rotate from an open to a closed position. The progressive rotation of the lever arm **142** compresses the flow channel **132** between the roller **149** and the ramp **148** to progressively constrict the cross-sectional area of the lumen of the flow channel **132** to progressively decrease the mass flow rate of fluid through the flow channel **132**. Progressive rotation of the lever arm **142** in the opposite direction causes the roller **149** to progressively decompress the flow channel **132** between the roller **149** and the ramp **148** to cause the cross-sectional area of the lumen of the flow channel **132** to rebound to progressively increase the mass flow rate of fluid through the flow channel **132**. FIG. 10 shows the pinch valve **140** in the partially open position.

In another embodiment illustrated in FIG. 11, the adjustable valve **140** is positioned within the lumen of the flow channel **132** and progressively decreases the mass flow rate of fluid that is drawn out of the corresponding cartridge **115** through the adjacent flow channel **132** by progressively advancing a needle tip **141** of the valve into the lumen of the flow channel **132** thereby progressively constricting the cross-sectional area thereof. Conversely, in operation, the adjustable valve increases the mass flow rate of fluid that is drawn out of the corresponding cartridge through the adjacent flow channel by progressively retracting the needle tip **141** of the valve from the lumen of the flow channel **132** thereby progressively increasing the cross-sectional area thereof. Examples of such an embodiment of the adjustable valve **140** include a needle valve (FIG. 11), a ball valve (not shown), or any other type of valve known to those skilled in the art that progressively occludes or expands the fluid path.

Referring to particularly to FIG. 11, a device is illustrated in which the adjustable valve **140** is a needle valve that is positioned within the lumen of the flow channel. The needle valve **140** has a valve body **146**, a conical needle **147**, and a control knob **142**. The conical needle **147** is positioned within a conical channel (not shown) in the valve body **146** and includes a distal tip **141** and a proximal threaded shaft **144**. The control knob **142** is substantially aligned with the needle axis such that progressive rotation of the control knob **142** causes the needle **147** to move progressively axially within the flow channel of the valve body **146** to progressively adjust flow rate. FIG. 11A shows the needle valve **140** in the fully opened position and FIG. 11B shows the needle valve **140** in the fully closed position.

Referring now to FIGS. 1, 2, and 5-7, the mixing and dispensing device **100**, **200** has a manifold assembly **130**, **230**. The system at rest is illustrated in FIG. 7A. As illustrated in FIGS. 1, 2 and 7, the manifold assembly **130**, **230** is configured to communicate through inlets **139**, **239** with each of the flow channels **132**, **232** to receive fluid from each corresponding cartridge **115**, **215** and to mix the fluids to form a mixture during operation of the device **100**, **200**. As illustrated particularly in FIG. 7C, when the dispensing pump assembly **150** is in the rebound state, fluid is drawn by the dispensing pump assembly **150** into the mixing chamber **137** through an inlet **139** from the cartridge **115** of the corresponding cartridge assembly to mix the selected volume of fluids to formulate the mixture in the mixing chamber **137** and to transport the mixture to the dispensing pump assembly **150**. When the nozzle **152** is subsequently depressed (i.e., the dispensing pump assembly is in the actuated state), the mixture is expelled from the dispensing pump assembly **150** through the nozzle **152** (FIG. 7B).

As illustrated in FIG. 5, the manifold assembly **130** comprises a manifold body **138**. The manifold body **138** has at least one side wall and a base that define a mixing chamber **137**. See FIGS. 5, 6. The volume capacity of the mixing

chamber **137** varies with actuation and rebound of the dispensing pump assembly **150** (FIG. 7 and FIG. 4, described below). There is a plurality of inlets **139** on any surface of the manifold body **138**. As illustrated generally in the figures, inlets **139** are in the base of the manifold body **138**. In other embodiments (FIG. 5C), inlets **139** are in at least one side wall of the manifold body **138**. Each inlet **139** is configured to communicate with a flow channel **132** of a corresponding cartridge assembly **120**. In embodiments, the inlets **139**, **239** of the manifold, assembly **130**, **230** are configured in a linear (FIG. 1) or a radial (FIG. 2) configuration.

As illustrated in FIG. 5, the manifold assembly **130** also has a seal **135** disposed within the mixing chamber **137** adjacent to the inlets **139** to substantially and simultaneously seal the inlets **139** as soon as the pump **150** is in a fully rebounded state and when the system is at rest in order to prevent the flow of fluid from the cartridges **115** through the flow channels **132** at any time other than when the dispensing pump assembly **150** is actuated. In embodiments, the seal **135** is a disc (FIG. 5B), a conical interface (not shown), or any other configuration that is sized and shaped to substantially and simultaneously seal the inlets **139**. The seal **135** is a face seal configured to substantially and simultaneously seal all of the inlets closed when the device **100** is not in operation to close communication between the mixing chamber **137** and the flow channels **132** in order to substantially prevent the anterograde movement of fluid from the cartridges **115** or flow channels **132** into the mixing chamber **137**, to substantially prevent the retrograde movement of fluid from the mixing chamber **137** into the flow channels **132** or the cartridges **115**, and cross-flow between flow channels **132** when the device **100** is not in operation. The configuration of the seal **135** to substantially and simultaneously seal the inlets **139** closed provides unexpected and surprising results in substantially preventing anterograde and retrograde fluid flow between the components **115**, **132**, **140** of the device when the device is not in use compared to other seals known in the art such as umbrella valves and the like, which cannot consistently open all of the inlets simultaneously, particularly where a plurality of flow channels each have a different mass flow rate.

Referring still to FIG. 5, the manifold assembly **130** also has a spring **134** disposed within the mixing chamber **137**. The spring **134** is moveable between a compressed position and an extended position. A piston **133** is disposed within the mixing chamber **137** between the seal **135** and the spring **134**. When the device **100** is not in operation, the inlets **139** are substantially sealed by the seal **135**. The outer diameter of the piston **133** is substantially the same as the inner diameter of the mixing chamber **137** to substantially limit the movement of the piston **133** within the mixing chamber **137** to a linear movement along a central axis within the mixing chamber **137**. In an embodiment, the side walls of the piston **133** have a plurality of channels **159** that extend substantially parallel to the central axis of the mixing chamber **137**. The channels **159** are configured to allow a small amount of fluid to flow past the piston **133** in order to decrease the frictional engagement of the outer surface of the piston side walls against the inner surface of the mixing chamber **137**.

As illustrated in FIG. 7, the mixing and dispensing device **100** also has a dispensing pump assembly **150** that is configured for communication with the mixing chamber **137** and a nozzle **152** that is positioned downstream from the dispensing pump assembly **150**. The dispensing pump assembly **150** has a pump chamber (not shown) that is defined by a pump body **158** having side walls and a base. The dispensing pump assembly **150** is configured to draw fluid from each of the cartridge assemblies **120** through the flow channels **132** into

11

the mixing chamber 137 via the inlets 139 and to the pump chamber. The dispensing pump assembly 150 may be any pumping system known to those skilled in the art that has a manual pumping action. In an embodiment, the pump chamber compressively drives the fluid through the nozzle 152. In another embodiment (not shown), the dispensing pump assembly 150 is electronically actuated with a manually actuated button that electronically operates the dispensing pump assembly 150 by means of a motor drive, for example. In other embodiments (not shown), the dispensing pump assembly 150 includes a piston with wiper seals driven through a cylinder and in combination with at least one check valve or wiper seal and a return spring.

Referring generally to the figures, and particularly to FIGS. 1, 2, and 7, the nozzle 152, 252 is configured for communication with the dispensing pump assembly 150, 250 and is configured to dispense the mixture when the device is in operation. The nozzle 152, 252 may be any of a variety of types of nozzle that is configured to dispense a spray, mist, drop, stream, etc. of a mixture of fluids.

FIGS. 1A, 2A, and 7 illustrate the flow of fluids through the mixing and dispensing device. Referring to FIGS. 1A, 2A, a fluid is contained in each cartridge 115, 215 and moves through the flow channels 132, 232 into the manifold assembly 130, 230 via the inlets 139, 239 and to the dispensing pump assembly 150, 250 for expulsion through the nozzle 152, 252. At rest (FIG. 7A), there is substantially no fluid flow through the device 100. As illustrated in FIG. 7A, the dispensing pump assembly 150 is positioned such that the spring 134 of the manifold assembly 130 is extended and engaged with the piston 133 of the manifold assembly 130 such that the piston 133 forces the seal 135 against the inlets 139 to substantially seal the inlets 139 closed. In operation of the device 100, a user adjusts the adjustable valve assemblies 140 to adjust a mass flow rate of fluid through the flow channels 132. The mixture of fluids is formulated by depressing the nozzle 152 (FIG. 7B) to actuate the dispensing pump 150 to express any prior mixture in the mixing chamber 137. The rebound of the dispensing pump assembly 150 (FIG. 7C) draws fluids at the adjusted settings from the cartridge assemblies 120. In the rebound state, the force of fluids being drawn from the cartridge assemblies 120 into the flow channels 132 and the inlets 139 forces the spring 134 to a compressed position that moves the seal 135 away from the inlets 139 to allow the fluids to enter the mixing chamber 137 to formulate the mixture at the user-adjusted setting. The mixture is then expelled through the nozzle 152 by depressing the nozzle 152.

Optionally, the mixing and dispensing device 100, 200, 300, 400, 1200 includes a purging assembly 199 to substantially remove any trace amounts of each fluid that remains in each flow channel following operation of the device. See FIG. 1J. The purging assembly 199 has a cartridge assembly that comprises a cartridge that contains a solvent and that communicates with the flow channels 132 of the device 100 to communicate with the manifold assembly 130, the dispensing pump 150, and the nozzle 152. The cartridge assembly 199 has an adjustable valve that opens or closes the flow channel to communication with an inlet in the manifold body to draw fluid into the mixing chamber, and pump the solvent through the mixing chamber and dispensing pump and out the nozzle. Optionally, a cartridge containing a solvent solution may be interchanged with one or each cartridge such that the solvent solution is flushed through the flow channels, manifold assembly, dispensing pump, and nozzle to substantially remove any fluids or mixture of fluids therefrom.

In another embodiment of the device illustrated in FIG. 3, the device 300 has at least two cartridge assemblies 320 each

12

comprising a cartridge 315. The cartridges 315 are the same as cartridges 115 described in connection with device 100, except that each cartridge 315 is positioned within the cartridge assembly 320 in a position that is inverted relative to the position of cartridge 115 in the cartridge assembly 120. The cartridge assemblies 320 are positioned linearly, non-linearly, or radially relative to each other as described in connection with the cartridge assemblies of the device 100. The cartridge assemblies 320, the manifold assembly 330, and the pump 350 are enclosed in a body 312. The body 312 is as described in connection with the body 112 of the device 100.

As illustrated in FIG. 3, each cartridge 315 has closure device 318, port 316, vent 313, optional bladder (not shown) as described in connection with the closure device 118, the port 116, and the vent 113, respectively.

A spike plate 314 is positioned upstream to the cartridge assemblies 320 and has at least two cannulated spikes 314a and at least two uptake ports (not shown). Each spike 314a has a proximal end that is configured to communicate with an interior of a corresponding cartridge 315.

The device 300 has at least two flow channels 332 each configured to communicate with an interior of a corresponding one of the cartridges 315 via coupling (not shown) that is mounted on or integral with the spike plate 314. Each spike 314a communicates with a corresponding coupling via a channel (not shown) that is formed below a surface of the spike plate 314 to transfer fluid from the cartridge 315 to the flow channel 332. The flow channels 332 are the same as flow channels 132 described in connection with device 100. The distal end of the flow channel 232 is connected to the corresponding coupling or uptake port (not shown) and the proximal end of the flow channel 332 communicates with a corresponding inlet 339 of the manifold 330.

The device 300 has at least two adjustable valves 340 each positioned to communicate with a corresponding one of the flow channels 332 and that adjusts mass flow rate of fluid that is drawn by the pump 350 from the corresponding cartridge 315 through the flow channel 332 each time the pump 350 rebounds. The adjustable valves 340 are the same as adjustable valves 140 described in connection with device 100.

As illustrated in FIG. 3, the mixing and dispensing device 300 has a manifold assembly 330 positioned downstream to the adjustable valve 340. The manifold assembly 330 is the same as the manifold assembly 130 described in connection with the device 100. The manifold assembly 330 comprises a manifold body 338 that has at least one side wall and a base that define a mixing chamber 337. There is a plurality of inlets 339 on any surface of the manifold body 338. Manifold assembly 330 is the same as manifold assembly 130 illustrated in FIG. 5, and has a seal 135 disposed within the mixing chamber 137 adjacent the inlets 139 and a spring 134 disposed within the mixing chamber 137. The spring 134 is moveable between a compressed and an extended position as described in connection with FIG. 7. A piston 133 is disposed within the mixing chamber 137 between the seal 135 and the spring 134. Each inlet 339 is configured to communicate with a flow channel 332 of a corresponding cartridge assembly 320.

As illustrated in FIG. 3, the mixing and dispensing device 300 also has a dispensing pump assembly 350 positioned downstream to the manifold assembly 330. The dispensing pump assembly 350 is configured to communicate with a nozzle 352 that is positioned downstream thereto. The dispensing pump assembly 350 and nozzle 352 are as described in connection with the dispensing pump 150 and the nozzle 152, respectively.

13

The flow of fluids through the device **300** is illustrated in FIG. 3A. During operation of the device, fluid is drawn by the dispensing pump **350** into the mixing chamber **337** through an inlet **339** and from the cartridge **315** of the corresponding cartridge assembly **320** to mix the selected volume of fluids to form the mixture and to expel the mixture from the nozzle **352** as described in connection with the device **100**, and particularly FIG. 7. In another embodiment of the device **400** illustrated in FIG. 4, the device **400** has at least two cartridge assemblies **420** each comprising a cartridge **415**. The cartridges **415** and cartridge assemblies **420** are the same as the cartridges **115** and the cartridge assemblies **120**, respectively, described in connection with the device **100**.

The cartridge assemblies **420** are positioned linearly, non-linearly, or radially relative to each other, as described in connection with the cartridge assemblies **120** of device **100**. As illustrated in FIG. 4, each cartridge assembly **420** includes a conduit **419**, a closure device **418**, port (not shown), vent (not shown), optional bladder (not shown) as described in connection with the closure device **118**, the port **116**, the vent **113** of the device **100**, respectively.

The device **400** also includes at least two flow channels **432**, a manifold assembly **430**, a dispensing pump **450**, and a nozzle **452**. The cartridge assemblies **420**, the flow channels **432**, the manifold assembly **430**, and the pump **450** are enclosed in a body **412**. The body **412** is as described in connection with the body **112**.

As illustrated in FIG. 4, the device **400** has at least two flow channels **432** each configured to communicate with the interior of a corresponding cartridge **415** and that transports the fluid from the cartridge **415** to the mixing chamber **437** of the manifold **430** when the device **400** is in operation. Each flow channel **432** has proximal and distal ends, a central axis, and a lumen that has a diameter that is proportional to a mass flow rate of fluid that is drawn by the pump **450** from the corresponding cartridge **415** through the flow channel **432** each time the pump **450** is activated. As shown in FIG. 4, the proximal end of the flow channel **432** is in communication with one of the inlets **439** of the manifold **430**. Optionally, the flow channel **432** is compressible or pliable, such as an elastomeric material, as described in connection with the flow channel **132**.

Optionally, the device **400** includes an adjustable valve (not shown) as described in connection with the adjustable valve **140** that is positioned adjacent to the flow channel **432** to additionally adjust the mass flow rate of fluid that is drawn from the corresponding cartridge **415**. In the device **400**, however, the adjustable valves **140** are not required because the diameter of the lumen of each flow channel **132** provides the variable mass flow rate of fluid from each cartridge **432** during operation of the device **400**.

As illustrated in FIG. 4, the mixing and dispensing device **400** has a manifold assembly **430** positioned downstream to the cartridge assembly **420**. The manifold assembly **430** is the same as the manifold assembly **130** described in connection with the device **100**. The manifold assembly **430** comprises a manifold body **430** that has at least one side wall and a base that define a mixing chamber **437**. There is a plurality of inlets **439** on any surface of the manifold body **438**. Manifold assembly **430** is the same as the manifold assembly **130** illustrated in FIG. 5 and has a seal **135** disposed within the mixing chamber **137** adjacent to the inlets **139** and a spring **134** disposed within the mixing chamber **137**. As described in FIG. 7, the spring **134** is moveable between a compressed position and an extended position. A piston **133** is disposed within the mixing chamber **137** between the seal **135** and the spring **134**.

14

Each inlet **439** is configured to communicate with a flow channel **432** of a corresponding cartridge assembly **420**.

As illustrated in FIG. 4, the mixing and dispensing device **400** also has a dispensing pump assembly **450** positioned downstream to the manifold assembly **430**. The dispensing pump assembly **450** is configured to communicate with a downstream nozzle **452**. The dispensing pump assembly **450** and the nozzle **452** are as described in connection with dispensing pump assembly **150** and the nozzle **152**, respectively, of the device **100**.

The flow of fluids through the device **400** is illustrated in FIG. 4A. During operation of the device **400**, fluid is drawn by the dispensing pump **450** into the mixing chamber **437** through an inlet **439** and from the corresponding cartridge **415** to mix the fluids to formulate a mixture and to expel the mixture from the nozzle **452** as described in connection with the device **100**, and particularly FIG. 7.

In another embodiment of the device illustrated in FIG. 12, the device **1200** has at least two cartridge assemblies **1220** each comprising a cartridge **1215**. The cartridges **1215** are the same as cartridges **115** described in connection with device **100**. As illustrated in FIG. 12, the cartridge assemblies **1220** are positioned non-linearly relative to each other, but the cartridge assemblies **1220** may alternatively be positioned linearly or radially relative to each other as described in connection with the cartridge assemblies of the device **100**. The cartridge assemblies **1220**, the manifold assembly **1230**, and the pump **1250** are enclosed in a body **1212**. The body **1212** is as described in connection with the body **112** of the device **100**.

As illustrated in FIG. 12, each cartridge **1220** has a closure device (not shown), port (not shown), vent **413**, optional bladder (not shown) as described in connection with the closure device **118**, the port **116**, and the vent **113**, respectively.

A spike plate **1214** is positioned downstream from the cartridge assemblies **1220** and has at least two cannulated spikes **1214a**. Each spike **1214a** has a proximal end that is configured to communicate with an interior of a corresponding cartridge **1215** and a distal end that is configured to communicate with one of flow channels **1232**. Each flow channel **1232** is integrally formed or molded into a compressible, such as elastomeric, silicone, or thermo-plastic elastomer (TPE) layer **1299** that is positioned and sealed between the spike plate **1214** and a second plate **1298**. The proximal end of the flow channel **1232** communicates with a corresponding inlet **1239** of the manifold **1230** via a port or other such opening in the second plate **1298**.

The device **1200** has at least two adjustable valves **1240** each positioned to communicate with a corresponding one of the flow channels **1232** and that adjusts mass flow rate of fluid that is drawn by the pump **1250** from the corresponding cartridge **1215** through the flow channel **1232** each time the pump **1250** rebounds. The adjustable valves **1240** are the same as the adjustable valves **140** described in connection with the device **100**. In the embodiment shown in FIG. 12, the adjustable valve **1240** is a paddle-actuated valve. The valve **1240** has paddles **1291** that protrude through openings in the body **1212** to turn a threaded shaft **1292** that compresses layer **1299** thereby compressing the corresponding flow channel **1232** to reduce the mass flow rate of fluid through the flow channel **1232**. The paddle **1291** is rotated in an opposite direction to turn the threaded shaft **1292** to decompress the layer **1299** to decompress the corresponding flow channel **1232** to rebound the mass flow rate of fluid through the flow channel **1232**.

As illustrated in FIG. 12, the mixing and dispensing device **1200** has a manifold assembly **1230** positioned downstream

15

to the adjustable valve 1240. The manifold assembly 1230 is the same as the manifold assembly 130 described in connection with the device 100. The manifold assembly 1230 comprises a manifold body 1238 that has at least one side wall and a base that define a mixing chamber 1237. There is a plurality of inlets 1239 on any surface of the manifold body 1238. As illustrated in FIG. 12, the manifold assembly 1230 also has a seal 1235 disposed within the mixing chamber 1237 adjacent the inlets 1239 and a spring 1234 disposed within the mixing chamber 1237. The spring 1234 is moveable between a compressed and an extended position as described in connection with FIG. 7. A piston 1233 is disposed within the mixing chamber 1237 between the seal 1235 and the spring 1234. The seal 1235, the spring 1234, and the piston 1233 are as described in connection with the seal 135, the spring 134, and the piston 133, respectively. Each inlet 1239 is configured to communicate with a flow channel 1232 of a corresponding cartridge assembly 1220.

As illustrated in FIG. 12, the mixing and dispensing device 1200 also has a dispensing pump assembly 1250 positioned downstream to the manifold assembly 1230. The dispensing pump assembly 1250 is configured to communicate with a nozzle 1252 that is positioned downstream thereto. The dispensing pump assembly 1250 and the nozzle 1252 are as described in connection with the dispensing pump 150 and the nozzle 152, respectively. During operation of the device 1200, fluid is drawn by the dispensing pump 1250 into the mixing chamber 1237 through an inlet 1239 and from the cartridge 1215 of the corresponding cartridge assembly 1220 to mix the selected volume of fluids to form the mixture and to expel the mixture from the nozzle 1252 as described in connection with device 100, and particularly FIG. 7.

While the foregoing has been set forth in considerable detail, it is to be understood that the drawings and detailed embodiments are presented for elucidation and not limitation. Design variations, especially in matters of shape, size and arrangements of parts may be made but are within the principles described herein. Those skilled in the art will realize that such changes or modifications of the invention or combinations of elements, variations, equivalents or improvements therein are still within the scope of the mixing and dispensing device as defined in the appended claims.

We claim:

1. A device, comprising:

at least two cartridges each configured to contain one of a plurality of fluids;

a manifold body comprising at least one side wall and base that define a mixing chamber, at least two inlets being positioned in the manifold body, each inlet configured to communicate with one of the cartridges through a flow channel positioned therebetween;

a spring positioned within the manifold body and moveable between an extended position and a compressed position;

a single seal positioned within the manifold body adjacent to the at least two inlets and configured to open the at least two inlets simultaneously;

a piston positioned within the manifold body between the seal and the spring, wherein a distance between the inlets and the piston is greater when the spring is in the compressed position than a distance between the inlets and the piston when the spring is in the extended position such that the piston positions the seal against the inlets when the spring is in the extended position and the seal moves away from the inlets when the spring is in the compressed position;

16

a dispensing pump configured to draw the fluid from each of the cartridges into the mixing chamber to form a mixture;

a plurality of adjustable valves, each valve positioned to communicate with one of the flow channels to adjust a mass flow rate of fluid that is drawn by the dispensing pump from the cartridge through the flow channel; and a nozzle configured for communication with the dispensing pump and to dispense the mixture.

2. The device of claim 1, wherein at least one of the cartridges is removable.

3. The device of claim 1, wherein each cartridge has a different volume capacity.

4. The device of claim 1, wherein each cartridge comprises a vent configured for entry of atmospheric air into the cartridge as fluid is removed when the dispensing pump is in a rebound state.

5. The device of claim 1, further comprising a bladder positioned in one of the cartridges and configured to hold the fluid.

6. The device of claim 1, wherein the inlets are positioned in the base of the manifold body.

7. The device of claim 1, wherein the inlets are positioned in the at least one side wall of the manifold body.

8. The device of claim 1, wherein each of the valves is independently adjustable.

9. The device of claim 1, wherein the adjustable valve comprises a clamp that releasably constricts the flow channel to adjust the mass flow rate.

10. The device of claim 1, wherein the adjustable valve comprises a roller that moves along an axis and a ramp that is positioned at an angle relative to the axis;

wherein a movement of the roller in a first direction along the axis constricts a lumen of the flow channel; and

wherein a movement of the roller in a second direction along the axis rebounds the lumen of the flow channel.

11. The device of claim 1, wherein the adjustable valve is positioned within a lumen of the flow channel.

12. The device of claim 1, further comprising a purging assembly in fluid communication with at least one of the flow channels.

13. The device of claim 1, further comprising a cartridge receptacle configured to receive a neck of one of the cartridges.

14. A device, comprising:

a plurality of cartridge assemblies each comprising a cartridge configured to contain one of a plurality of fluids;

a manifold assembly, comprising:

a manifold body comprising at least one side wall and base that define a mixing chamber, at least two inlets being positioned in the manifold body, each inlet configured to communicate with one of the cartridges through a flow channel positioned there between;

a spring positioned within the manifold body and moveable between an extended position and a compressed position;

a single seal positioned within the manifold body adjacent to the at least two inlets and configured to open the at least two inlets simultaneously;

a piston positioned within the manifold body between the seal and the spring, wherein a distance between the inlets and the piston is greater when the spring is in the compressed position than a distance between the inlets and the piston when the spring is in the extended position such that the piston positions the seal against the inlets when the spring is in the extended position

17

- and the seal moves away from the inlets when the spring is in the compressed position;
- a dispensing pump assembly configured to draw the fluid from each of the cartridges into the mixing chamber to form a mixture;
- a plurality of adjustable valves, each valve positioned to communicate with one of the flow channels to adjust a mass flow rate of fluid that is drawn by the dispensing pump from the cartridge through the flow channel; and
- a nozzle configured for communication with the dispensing pump assembly and to dispense the mixture.
15. The device of claim 14, wherein each cartridge assembly further comprises:
- a closure device configured to substantially close the cartridge;
- a conduit positioned within the cartridge;
- a port positioned within the closure device and having an opened and a closed position and configured to communicate with the conduit and the corresponding flow channel in the opened position; and
- a vent that is configured for entry of atmospheric air into the cartridge as fluid is removed when the dispensing pump is in a rebound state.
16. The device of claim 14, further comprising a purging assembly in fluid communication with at least one of the flow channels.
17. A device comprising:
- at least two cartridges each configured to contain one of a plurality of fluids;
- a manifold body comprising at least one side wall and base that define a mixing chamber, at least two inlets being positioned in the manifold body, each inlet configured to communicate with one of the cartridges through a flow channel positioned there between;
- a seal positioned within the manifold body adjacent to the at least two inlets;
- a piston positioned within the manifold body adjacent to the seal;
- a spring positioned within the manifold body and moveable between an extended position that engages the piston to

18

- move the seal to a closed position and a compressed position that enables the piston and seal to move away from the inlets;
- a dispensing pump configured to draw the fluid from each of the cartridges into the mixing chamber to form a mixture; and
- a nozzle configured for communication with the dispensing pump and to dispense the mixture;
- wherein an outer surface of a side wall of the piston comprises at least one channel that extends substantially parallel to a central axis of the mixing chamber.
18. A device comprising:
- a plurality of cartridge assemblies each comprising a cartridge configured to contain one of a plurality of fluids;
- a manifold assembly, comprising:
- a manifold body comprising at least one side wall and base that define a mixing chamber, at least two inlets being positioned in the manifold body, each inlet configured to communicate with one of the cartridges through a flow channel positioned there between;
- a seal positioned within the manifold body adjacent to the at least two inlets;
- a piston positioned within the manifold body adjacent to the seal; and
- a spring positioned within the manifold body and moveable between an extended position that engages the piston to move the seal to a closed position and a compressed position that enables the piston and seal to move away from the inlets;
- a dispensing pump assembly configured to draw the fluid from each of the cartridges into the mixing chamber to form a mixture; and
- a nozzle configured for communication with the dispensing pump assembly and to dispense the mixture;
- wherein an outer surface of a side wall of the piston comprises at least one channel that extends substantially parallel to a central axis of the mixing chamber.

* * * * *